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The Dock & Harbour Authority

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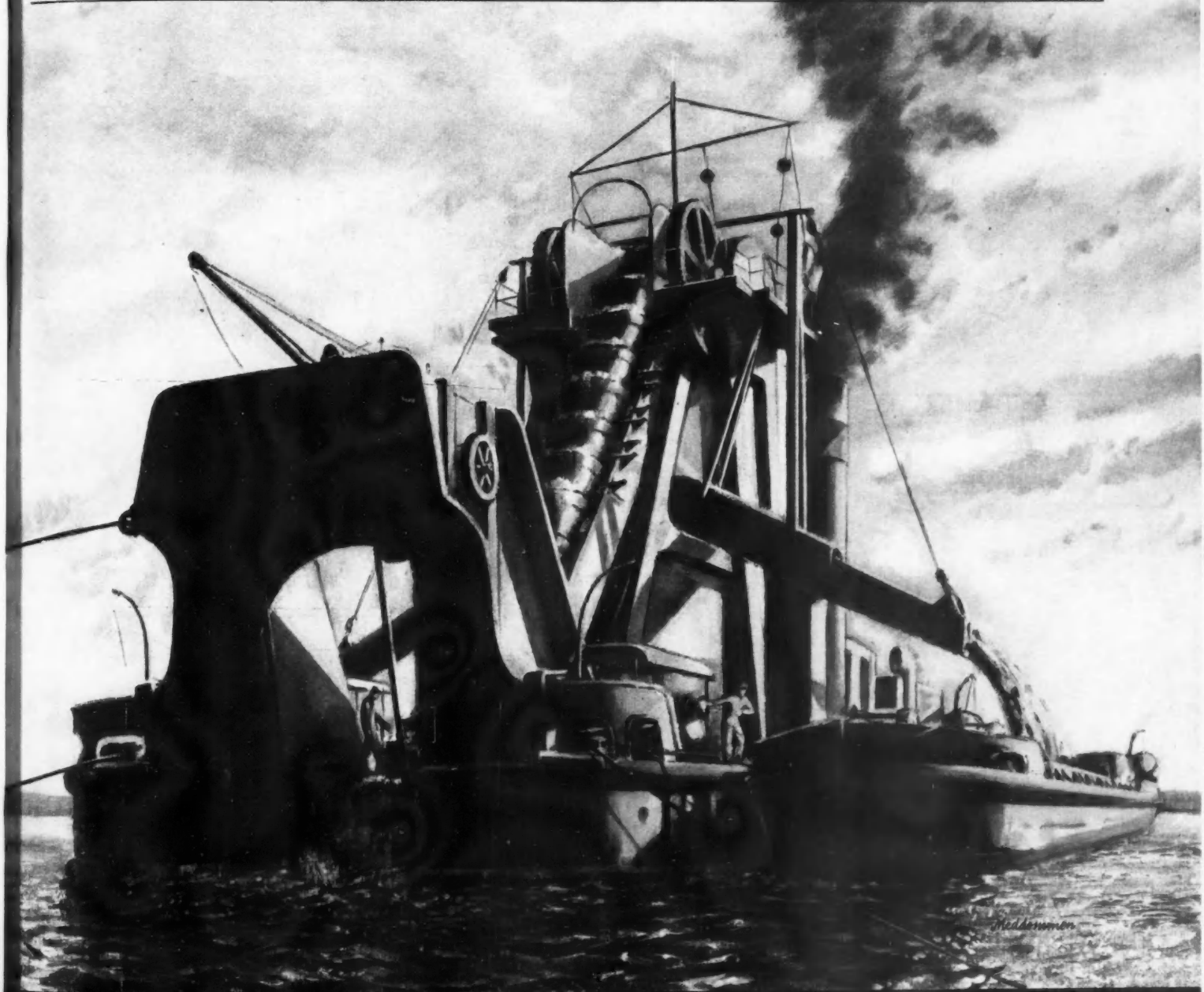

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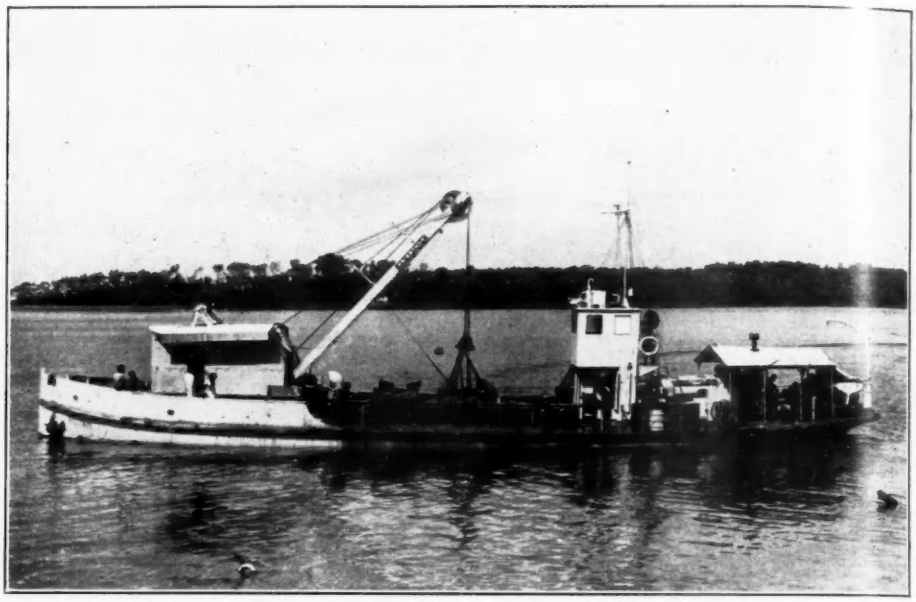

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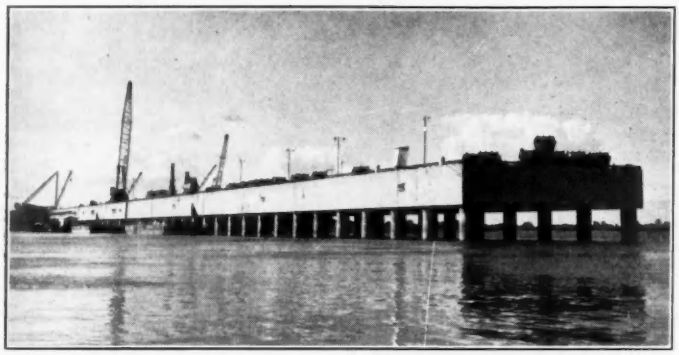
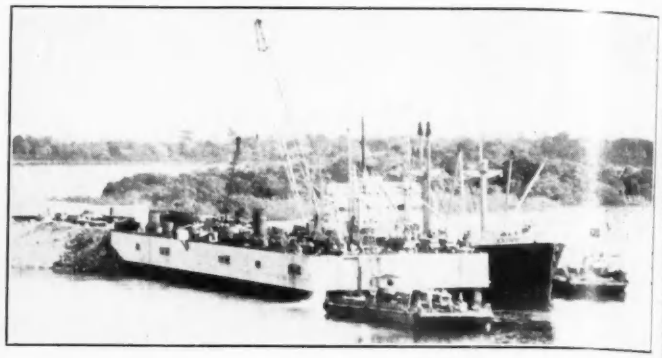
1. *Orinoco Mining Company's new ore and cargo handling dock on the Orinoco River, Venezuela. Composed of 3 units, this DeLong dock is 1,130 ft. long, 82 ft. wide, and 15-ft. deep.*

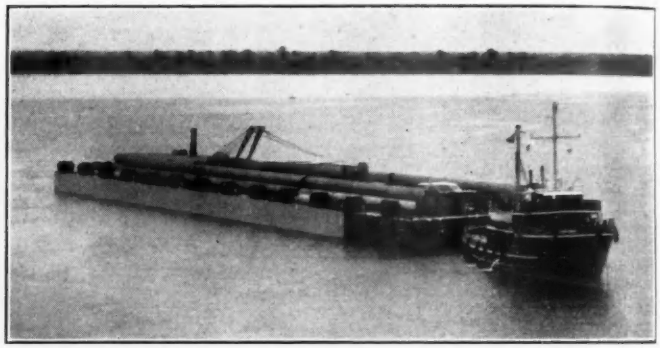


2. *A week after arrival at Orinoco River site, first dock section 3[illegible] ft. long berths ship, and unloading begins. Two additional units make this pier 1,130 ft long.*



DeLong airjack transforms sea going dock-barge into ore and cargo pier!

3. *Dock sections were economically frabricated at an Orange, Texas yard and launched for towing to pier site.*



4. *Loaded deck section arriving at site on Orinoco River, Venezuela, after being towed across 3,000 miles of ocean. Dock carried caissons crane, Airjacks, compressors, generators, and all other installation gear.*

Cuts time, costs! Field work is practically eliminated in dock construction, due to the development of the patented DeLong Airjack. This new technique of dock construction speeds installation, cuts costs.

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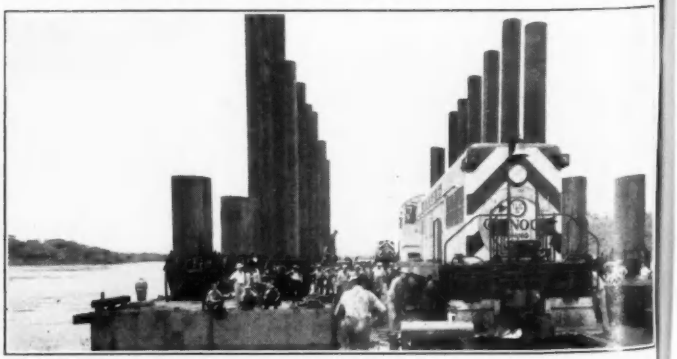
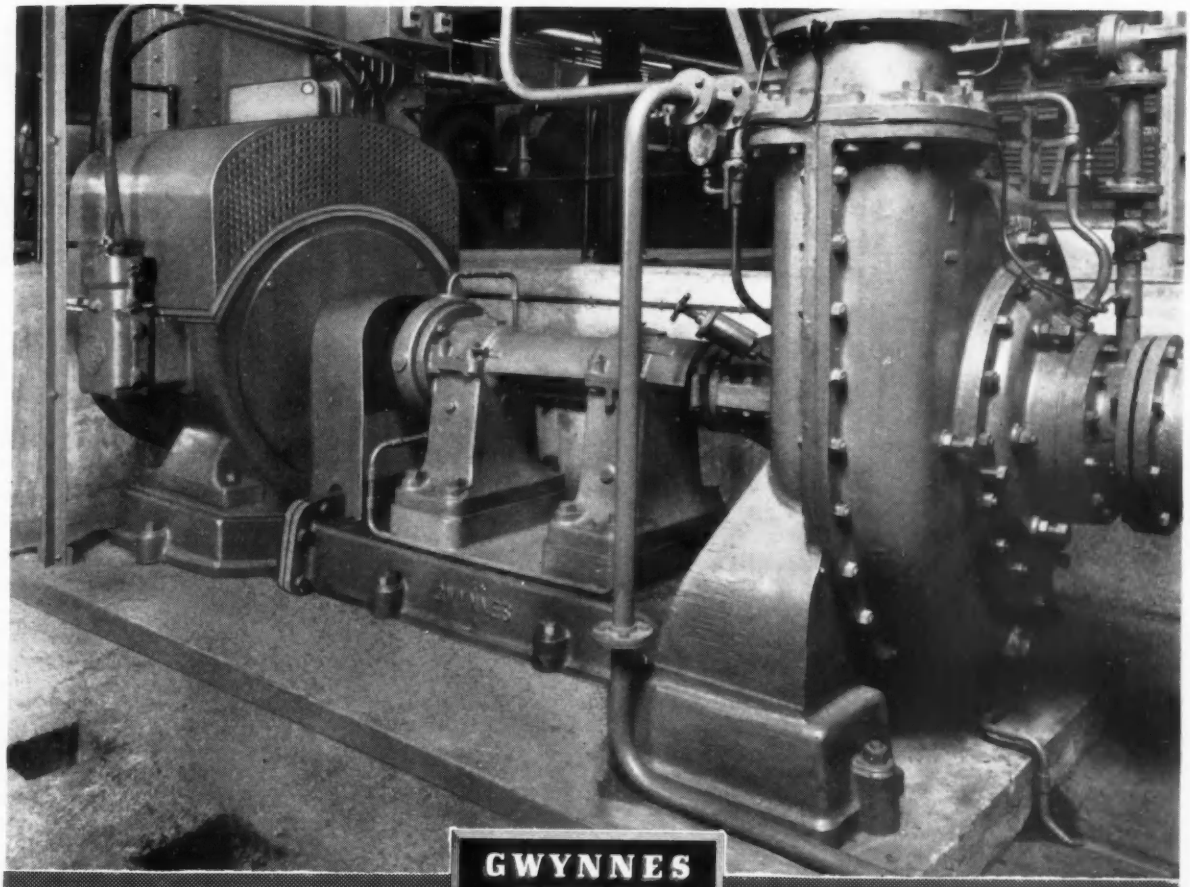
5. *Crane placing 6 ft. diam., 100 ft. long steel caissons in wells fitted with Airjacks. Crane, Airjacks and other equipment were later transferred to second and third sections for erection purposes.*

6. *Caissons held in position by Airjacks until dock barge is jockeyed into final position. Caissons are then dropped to river bottom and Delong Airjacks lift dock to final elevation. Control is so precise, height of dock can be regulated to 1/32 of an inch.*





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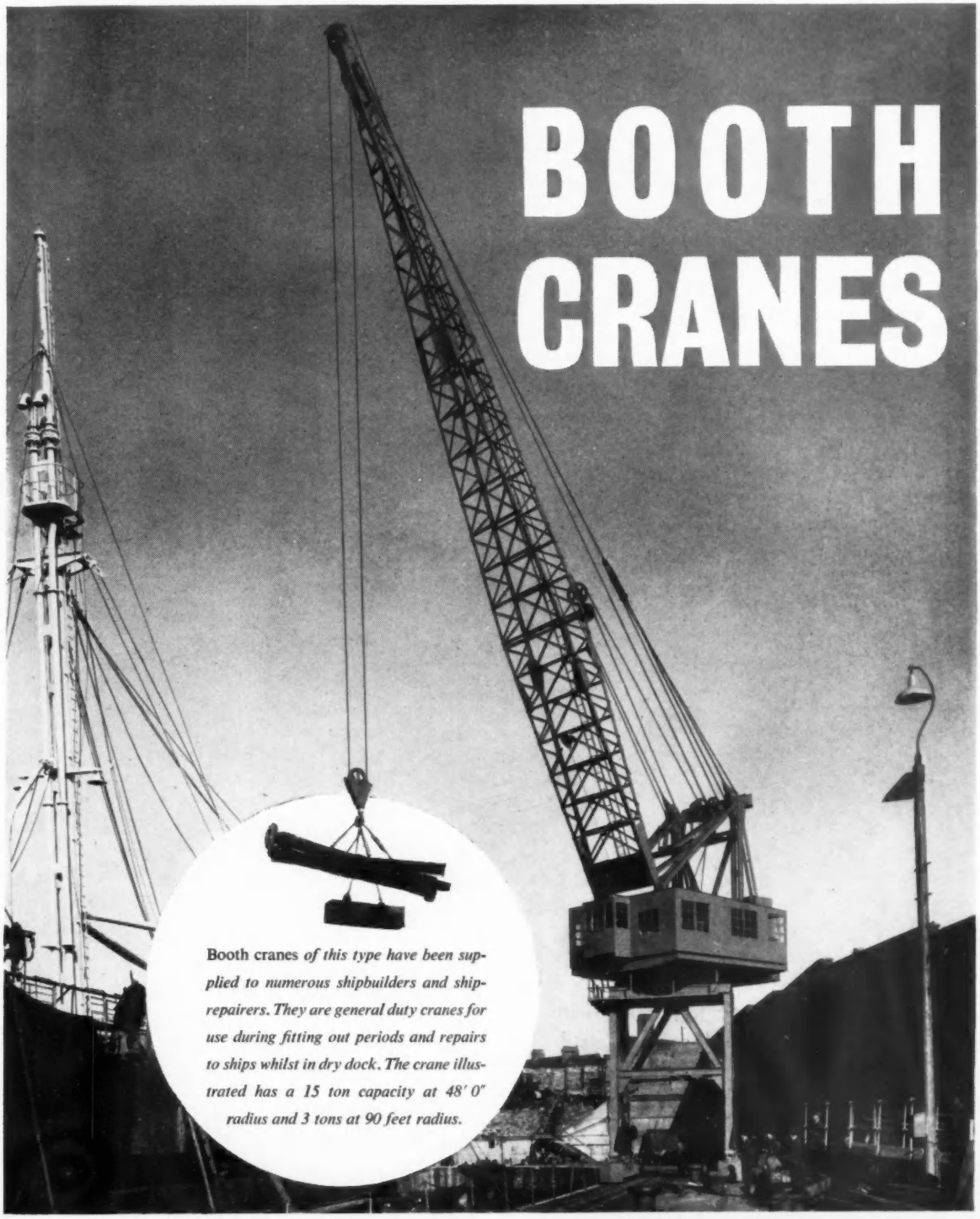

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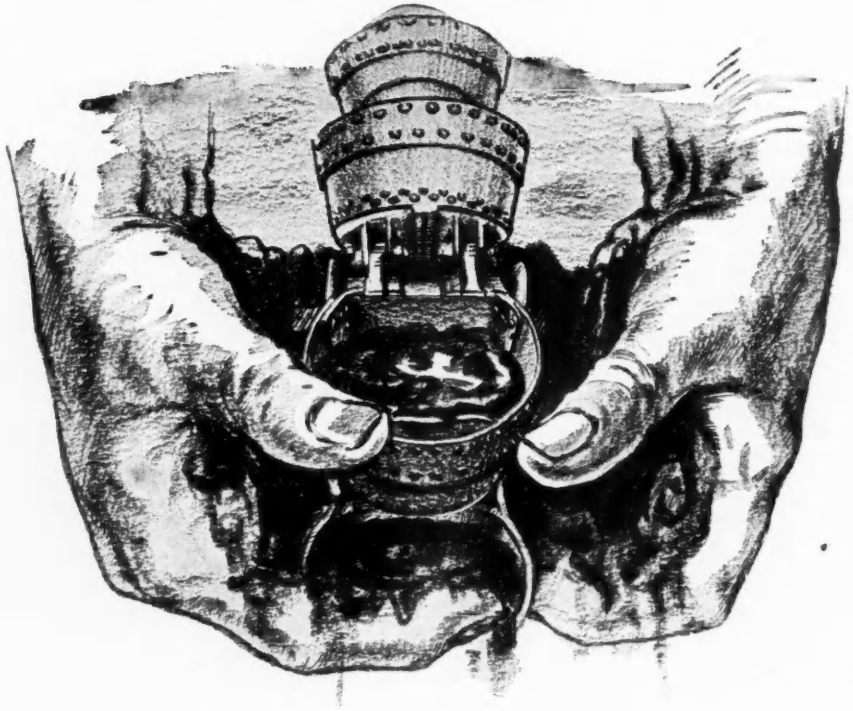

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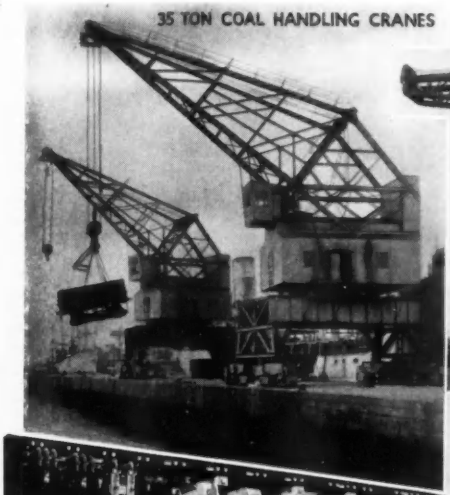
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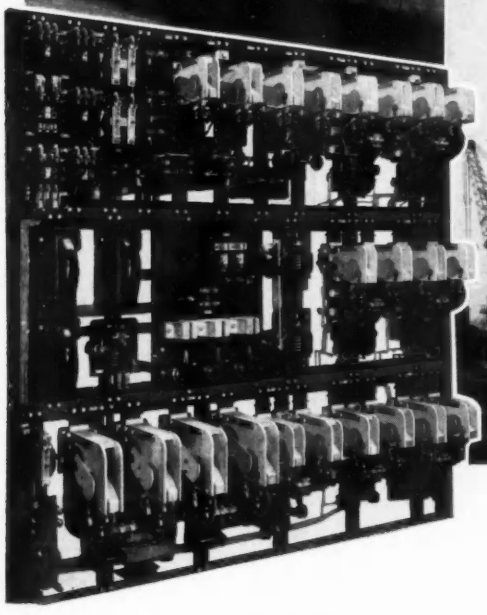

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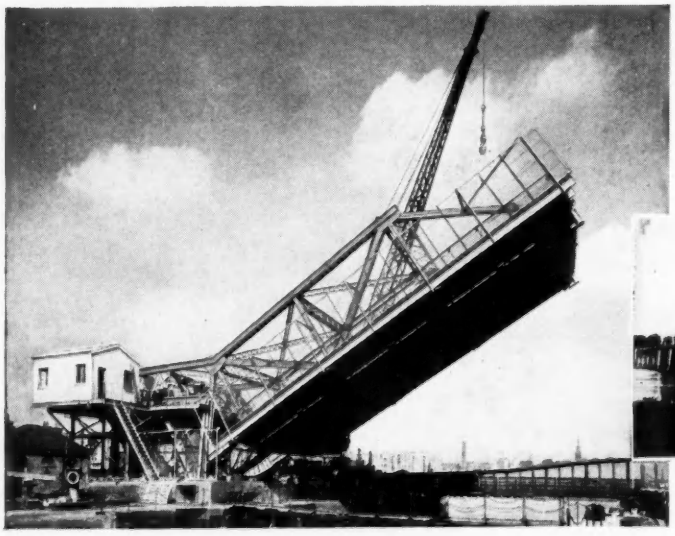

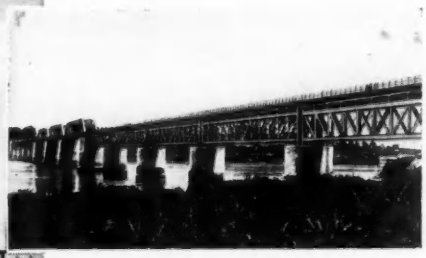

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The Dock & Harbour Authority

An International Journal with a circulation extending to 72 Maritime Countries

No. 396

Vol. XXXIV.

OCTOBER, 1953

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Editorial Comments

No. 4 Dry Dock, Genoa.

It is most important that all commercial ports should have full provision for the rapid repair and fitting out of vessels, which must include dry-docking facilities adequate for the majority of vessels using the port. The implication is that Mercantile dry docks must keep in step with the development of ship design. During this century we have witnessed a striking change in the average dimensions of sea-going ships: the block dimensions have increased, particularly in tankers, as was forcibly pointed out by Mr. Champness in his paper on " Large Dry Docks " presented at the Institution of Naval Architects last March, and reproduced in the May issue of this Journal. He showed that the length and breadth of vessels have increased about 30 per cent., whereas the draught has only increased 12½ per cent., due mainly to the physical limitations in respect of depth of the approach channels to the world ports.

As a consequence of this, Naval Architects, to obtain the required tonnage, have been forced to increase the length and breadth, with the result that the greater number of existing dry docks are inadequate to accommodate present-day liners and merchantmen. Dock owners are therefore faced with the serious problem of adapting their property to not only the requirements of the present time, but must allow, as far as possible, for the future trend in ship sizes, particularly if, as seems likely unless arrested, the present trend continues.

This latter difficulty to which we have often drawn attention, could be considerably alleviated by a greater measure of collaboration between shipowners and dock owners. To lengthen a dock is not a difficult operation, but to increase the width also is tantamount to building a new dock; a work of formidable financial proportions at present-day prices.

To overcome some of the difficulties of site and provide a dock of more than the usual adaptability, Mr. Champness suggested the construction of a dock which could be built in deep water lying lengthwise parallel to the shore, with two entrances and intermediate gates to divide the length so that both ends of the dock could be used independently, or the whole length as required.

The article which we publish in this issue on No. 4 Dry Dock, Genoa, will therefore be of special interest since it was constructed entirely in the deep water of the Grazie Basin, Genoa, and has many features of construction pertinent to this useful suggestion. In 1937, we published a description of the proposed scheme, but as the dock was not completed when war broke out, little information was vouchsafed to the public. As a matter of interest, the entrance width of this dock is one-tenth of the length, plus 39-ft., which is above the world's average.

Sea Defence and Floods.

The disastrous floods from the sea which devastated the coasts of East Anglia, Holland and Belgium in the early days of last February will not fade quickly in Dutch or British memories.

Besides the regrettable loss of life and the damage and destruction of towns and villages in both countries, over 300,000 acres of low-lying land were flooded in Holland, while in Great Britain, the sea inundated 150,000 acres—two-thirds of them fortunately only briefly—and the damage extended over 1,000 miles of coastline and involved 1,200 breaches in the defences.

In the time that has elapsed, by miracles of organisation, co-operation and toil, breaches were repaired in some fashion against later winter tides. Since then, sea defences in this country have been more or less permanently repaired, strengthened and raised; the Ministry of Agriculture has recently announced that the work has now been virtually completed, at a cost approximating £17 million. The Ministry also stated that as far as can be assessed, the new defences will be as strong as, and in many places far stronger, than before the floods.

In Holland, however, where the damage to dykes and flooding was far in excess of that sustained in Great Britain, the picture is not so satisfactory. Permanent work is by no means completed, although broken dykes have been everywhere, patched up with sandbags, sunken ships and caissons, except on the island of Schouwen-Duiveland where repairs are still proceeding.

Elsewhere efforts are now being concentrated upon making the temporary repair work strong enough to withstand whatever strains and assaults the storms of the coming autumn and winter may impose, particularly in the areas which were so disastrously flooded in February.

In a number of cases the traditional dyke-building methods have had to be abandoned in favour of speedier techniques. For example, expensive asphalt has been used in many places instead of the time honoured clay, because clay was scarce and asphalt was readily obtainable.

It is true that the chances are against an immediate recurrence of the combination of adverse circumstances responsible for the February floods. Some students of history have stated that it is 600 years since a comparable flood occurred, while others put the period at 250 years.

It is a disconcerting fact, however, that there was some flooding of the sea defences on the East Coast in 1938 when new height standards of protection were set. Moreover, in 1949 record tides necessitated a further increase in height for the sea defences, which were again overtopped in 1953.

Granted the necessity of successively raising coastal sea defences to flood prohibitive levels, the effect of so doing in river estuaries is by no means certain and in this respect the River Thames is specially vulnerable, with London and the docks in the higher reaches.

As to the cause of the frequent recurrence of flood circumstances that have taken place over recent years, there is considerable doubt. Some aspects of the phenomena seem to support one theory advanced that we are in an inter-glacial period and that the melting polar ice is having an effect upon sea levels, tidal currents and winds.

There seems to be no question, as stated in these columns in our February issue, that research in the fields of meteorology, geophysics, maritime and hydraulic engineering and other sciences allied to the subject can best be prosecuted on a national basis.

It is only through a co-ordinated coast defence and possibly land reclamation administration, that full appreciation of all the factors involved can be obtained and agreement reached in the

Editorial Comments—continued

formulation of a co-operative coast defence policy. In this respect no doubt the Waverley Committee set up by the Government early in the year will, in due course, have some pronouncement to make.

Oscillations of the Sea.

The instalment on page 169 in this issue concludes the article dealing with the above subject.

On looking back over the whole series, there is much that ought to interest the civil engineer, in connection with coast erosion, sea defences and the design and siting of new harbours. If they are prepared to accept the implications of Wilson's work, a great deal of preliminary study should be undertaken before a new harbour is planned. This should include a survey of local long waves which may generate seiches inside a harbour, an appreciation of the meteorological conditions for at least a thousand miles in every seaward direction, and finally the designing of a harbour which will react in the least possible way to the long waves. Unfortunately the science and practice of wave recording, particularly in respect of very long waves is not well developed, nor are there the instruments available, as yet. The moral however is obvious, namely that the amenity offered by a harbour depends on vast influences far from the coast, and that these should be at least considered as carefully as facilities and time will allow, before a new harbour is committed to the drawing board.

International Hydrography.

Coupled with sea defence works and the design of harbours and their approaches and safe navigation generally, is of course the survey of the ocean bed and coastal areas. The science of hydrography, contrary to the study of waves, is in an advanced stage with instruments of a highly developed character and most maritime countries have vessels specially designed for hydrographic survey purposes. It is satisfactory to know that a great deal of collaboration exists in the dissemination of the data and information now available.

The annual report of the Hydrographer of the Royal Navy for 1952 not only gives the usual details of the work done by the eight surveying ships of the regular navy, but also gives full credit to the great help received from outside sources. Some of this is by voluntary observations made by various master mariners who, with the accurate and careful use of the echo-sounders fitted in practically all modern ships, have been able to supply the Department with invaluable information about areas which have not been covered by the regular surveying ships recently. By far the greater part, however, comes from the Hydrographic Departments of Commonwealth and foreign governments under the established custom of a free interchange of new charts and other documents. During the year the Hydrographer received from such governments 225 new charts and 621 corrected editions. Special mention is made of the work done by the Danish research ship "Galathea," which cruise produced such remarkable results. Port authorities all over the world, responsible for surveying their own areas, have supplied invaluable information, not only in the ordinary surveying work but in the various ancillary branches of modern hydrography.

Labour Troubles on the Waterfront.

Reviewed in this issue are two American publications dealing with labour conditions on the waterfront in New York and America, and with a study of dock labour disputes in Great Britain. They are of importance in the light of the present situation in New York Docks where there is an uneasy truce following a strike early this month and a subsequent resumption of work upon a court order being issued under the Taft-Hartley Act. If only the question at issue was one of wage rates, agreement might be reached, but as our reviewer points out, much deeper issues are concerned. The American Federation of Labour has now sponsored a rival union and the Port of New York Crime Commission, who published one of the American Reports under review, will surely prevent deeper matters and their important recommendations being sidetracked once again. The latest reports in the American press seem to indicate that the employers are prepared to make a stand.

It is possible that the 80 days breathing space, which it is expected the Court will eventually order, will not be time enough to settle these matters. If such proves to be the case, the prospect of a major disturbance is serious. The situation may well have repercussions on this side of the Atlantic unless the matters at issue are made widely known before further strikes occur on the Eastern Seaboard of America. The lessons of the Canadian Seamen's strike in 1951 and its repercussions among dock workers in the United Kingdom should be studied once again as a warning.

It is satisfactory to learn, as we go to press, that a delegate conference representing the four dockworkers' unions in Great Britain, have decided to accept the awards of the Board of Arbitration, which recently considered the unions' claims for an increase in wages to conform with the latest cost of living index. At the same time, the remarks of Mr. Arthur Deakin, general secretary of the Transport and General Workers' Union, should be seriously considered. He told the delegates that the circumstances of the recent Liverpool dock strike had been examined. The unions knew that troublemakers would try to involve the Liverpool dockers some time before the strike occurred. It had also come to the knowledge of the unions that attempts would be made next January to stage unofficial strikes in the Port of London on any pretext that could be found. Such stoppages would be organised with the object of making the dockers "sacrificial lambs for political adventurers who are assiduously pursuing a Communist line." He warned the delegates that the dockers "must resolutely set their faces against any form of exploitation and the consequences that could follow any unofficial action." It is to be hoped that this warning will be taken to heart.

Topical Notes

Rehabilitation of Korean Harbours.

A scheme estimated to cost $1,250,000 is now in hand for the rehabilitation of the harbours of the Republic of Korea. The project, which also includes the repair of several dredges, is under the auspices of the United Nations Korean Reconstruction Agency.

A new dredge, the "Chinhae Man," which has been constructed by the Hawaiian Dredging Company, has arrived in Pusen, together with a tug and attendant dredging equipment. Approximately $600,000 will be expended on this part of the project.

Carriage of Dangerous Goods.

The Ministry of Transport has issued Amendments No. 4 to the rules embodied in the Report of the Departmental Committee on the Carriage of Dangerous Goods and Explosives in Ships, which were published in 1952. Copies of the amendments, dated June 15 by the Ministry, involving some 60 items, can now be obtained from the Stationery Office, price 9d. When issuing the first three amendments earlier this year, the Ministry referred to the need to keep the rules up to date in the light of current experience and in order to provide for the packing and stowage of new substances. To achieve this purpose the Ministry announced its intention to publish amendments from time to time.

Large Floating Dock Built in Japan.

What is claimed to be the largest floating dock in the Orient has just been completed by the Kawasaki Heavy Industry Co. in Kobe, at a cost of 516 million yen (about £600,000). The work was started a year ago.

The dock consists of heavy outer walls over six pontoons, the overall width between the two walls being 36 metres (inside width 26.4 metres), the total length being 172.8 metres. The maximum width available for vessel entry is 25.8 metres, while the draft will be 7.7 metres. The most up-to-date equipment will be provided, and on each of the outer walls a five-ton crane will be erected.

The dock is capable of handling a 22,000 gross ton liner, and has a lifting capacity of 13,000 tons. It is estimated that the yearly repairing capacity will total some 230,000 tons.

No. 4 Dry Dock, Genoa

Interesting Features of Design and Construction

By R. R. MINIKIN.

THE remarkable development of naval architecture to meet the needs of modern sea-going traffic and transport has increased the demands upon and complicated the problems of Port Authorities and their staffs. In most cases this arises from the fact that the majority of the large world ports are growths or gradual development concentrated around centuries old commercial centres which originally owed their attraction to political or natural protection when in the embryo stage. What is pertinent is that these old ports thrived, and continue to do so in spite of the many structural and planning disadvantages.

One of the oldest of the world ports is Genoa, which had its origin as a small land-locked bay tucked in a rocky coast and verging on deep water, and, as already described in the *Dock and Harbour Authority** the only protection from southerly gales was the short rubble breakwater arm now extended and known as the Vecchio Mole. The only possibility of extension to the old port was to enclose a portion of the sea. This was commenced in the year 1890 and in 1914-18 the Giano Mole was extended. In the elbow of this breakwater and the then outer harbour Nos. 1 and 2 dry docks were built. These were soon found to be inadequate for the trade of the port and it was not until 1925 that No. 3 dry dock construction was commenced. It was almost entirely built in open excavation and construction between Nos. 1 and 2 dry docks, and was finished in 1928. At that time it could cope with the largest of Italian vessels.

Within a year or two of the completion of No. 3 dock the Port Authority re-opened considerations, both economic and technical, of the need of a yet larger dry dock. The famous Italian liner "Rex" was then in service and No. 3 dry dock was not adequate to dock her as the width of the vessel left a clearance between the hull and the walls of the dock of one metre only. It was then decided to go ahead with a project for a dock 350 metres (1,148 feet) long with two entrances; located more or less parallel to the Guardiano Mole with one smaller entrance piercing the Giano Mole from the Outer Harbour and the main entrance in the deep water of the Grazie Basin (Fig. 1). The dock was to be subdivided into three with two intermediate gates. Vessels entering through the Giano entrance gate were to be limited to a length of 120 m. (393 feet).

However further technical studies of construction to fit the requirements not only of the Navy, but also of the Mercantile Marine resulted in the definite decison to build a dock 280 m. (918 feet) long, 40 m. (131 feet) entrance width, 14 m. (45.9 feet) floor level below M.W.L. and draught on the sill of 41.6 feet. The construction was authorised in November, 1934, and work commenced in May 1935.

The Project.

Close soundings over the proposed site showed that the rock bed lay at 17-20 m. with here and there points of rock at 13 m. It was foreseen that the foundations of the walls and the threshold of the one entrance gate of the adopted scheme would have to be carried down to impermeable rock so that once they were constructed, and the gate sealed, the basin could be pumped dry to allow the remainder of the internal work to be carried on under the open sky.

The thickness of the flanking walls was projected at 9 m. (29.5 feet) for the first 10 m. depth from the W.L. and then to increase to 14 m. (45.9 feet) to the foundations. When the drawing board proposals were put out to tender the successful contractors, a combination of engineers and financiers, submitted a method of construction in which they had special experience. They suggested that the side walls of the dock could be built in two stages; (a) the first stage to found the wall in a series of caissons of lesser width than the finished wall supported by transverse counterforts also of caissons of reinforced concrete and, when completed, sealed by entrance gate and pumped out; (b) the second stage, to carry out the internal work in the dry bringing up the walls to the full finished shape and width of section integral with the floor.

They further suggested that the caissons of stage (a) should be designed as a continuous series of virtual horizontal arches of short

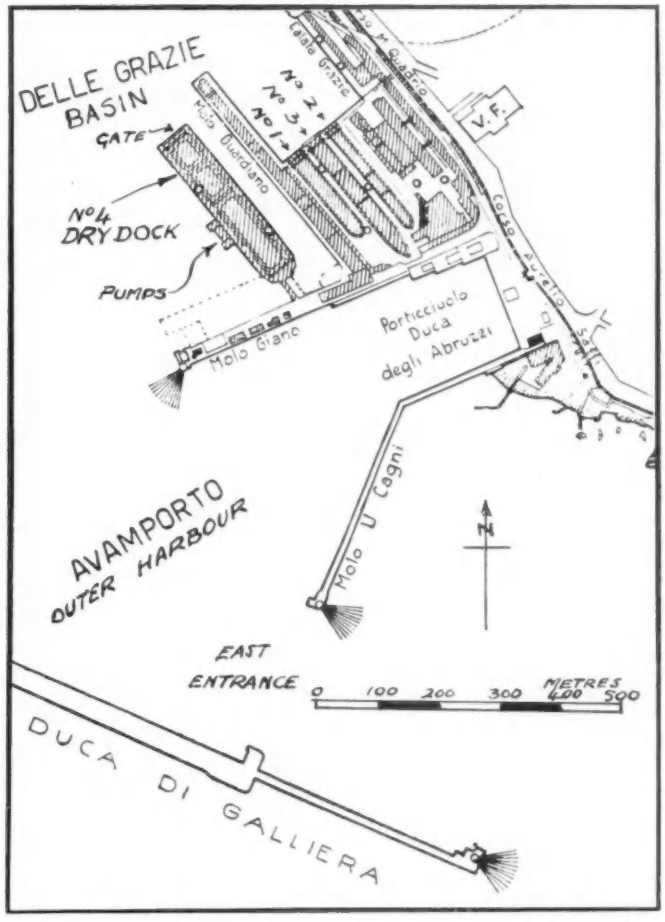


Fig. 1. Plan of the dry dock area—in the lee of the Giano Mole. The whole of these works have been recovered from the sea. Note that No. 3 dry dock is sandwiched between Nos. 1 and 2 and No. 4 lies isolated to the West of the fitting-out quay, Guardiano. The dotted lines show widening of the Giano Mole for workshops.

span abutting at the springing on the transverse caissons, requiring a total of 47 cellular R.C. units of special design (Fig. 2); 24 for the actual arched wall spans; two for the entrance heads and 21 designed specially for transverse support as abutments for the walls and subsequent partial demolition. The wall units were 20.80 m. long by 6.20 m. wide with a total average depth of 20.50 m. including compressed air working chamber; the transverse units were 20 m. long by 6.50 m. wide and similar depths to those of the wall. The ceiling slabs of the air chamber were all 0.50 m. thick. The longitudinal skin walls of all units were

* "The Port of Genoa," The Dock and Harbour Authority," No. 384, Vol. XXXIII, October 1952.

No. 4 Dry Dock, Genoa—(continued)

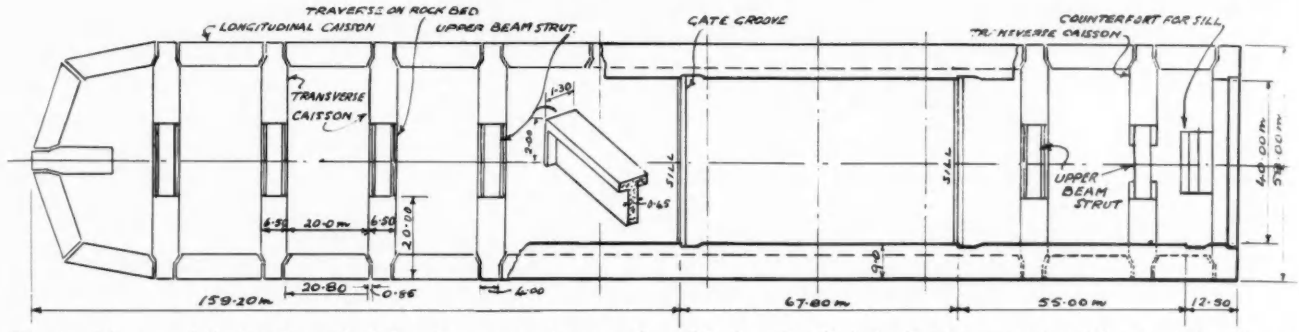


Fig. 2. Diagram of the locations of reinforced concrete caissons and partial plan of wall deck showing compartmental gate abutments and sills. Inset sketch of R.C. beam strut placed between opposing transverse units on specially prepared seating at water level. When recovered after completion of dock they were used for bridge beams to the Mole.

parallel and widths of units were uniform for full height, excepting for the abutment end of the transverse caissons (Fig. 4).

Cofferdam Walls.

The first operation of construction was to build the caissons in basins owned by the contractors. Here the units were built up to a height of 11 m. (36 feet) including the working chamber, floated out to a backwater of the port where their heights were increased sufficiently to bottom on their allotted places on site. Later it will be seen that during the fabrication of these shells they were provided with stickers of reinforcing bars and registration grooves and slots for joining up to adjacent units.

Simultaneous with the above the sea bed at the site was being carefully cleared of mud and loose material by a dredger of the port, of which the leaders had to be lengthened about 36-ft. to enable it to work effectively to a depth of 72-ft. On the less jagged portions of the rocky sea bed a preliminary levelling up for the cutting edges of the wall caissons was facilitated by the tipping of selected rubble over the area to give sufficient resistance and preserve the registered plumb in position. However where the rocky jagged ledges were too high it was found more effective to use a floating rock breaker or a mobile floating pontoon equipped with a complete outfit of air compressors, a compressed air working chamber suspended from the pontoon by adjustable links, and fitted with extensible access tubes and air pressure relieving locks (Fig. 5).

The greatest care was exercised at the beginning of sinking to regulate the travel uniformly all round the cutting edge of the R.C. wall caissons by judicious regulation of the kentledge, and the filling in of the cells above the working chamber. This made the initial work extremely slow but once the unit was completely entered into the rock stratum the travel was accelerated. The filling in of the cells was of concrete mixed with 300 kgs. of cement to one cubic metre of concrete (about 1 : 2 : 4) of 450 kgs. per sq. cm. (6,300 lbs. per sq. in.) after 28 days. The concrete test pieces gave crushing strengths of 140 to 250 kgs. per sq. cm.

When the wall caissons had penetrated unfissured and impermeable rock sufficiently, and were trimmed to plumb, the working chambers were filled with concrete. After setting they were injected with cement grout at a pressure of 7 atmospheres to fill voids and inequalities of shrinkage.

The registration for line of all units was extremely good, and due to the extreme care and lack of haste at the beginning of sinking few inequalities arose.

Joints between Caissons.

A most interesting feature of the wall construction was the careful and elaborate treatment of the joints between the wall units and the transverse caissons forming the abutments of the horizontal arch. In the end surfaces of all wall units and in the narrower throated end surfaces of the counterforts slots were cast from top to bottom (Fig. 4), near the external and internal faces of the wall. The gaps between the units were 0.80 m. to 1 m. wide and the slots on one unit were immediately opposite the slots on its neighbour. Sturdy R.C. slabs were specially fabricated to drop into those vertical grooves to enclose the gap. They extended from the sea bed to just above water level. The enclosed space was then filled with selected broken stone to a height about 10-ft. below the top; this was levelled to provide a platform for men working when water was later pumped out of the space.

The open top was then covered over with a thick concrete slab through which the neck of a compressed air access tube passed, complete with pressure relieving chamber, indicated by circle in sectional plan. When it was adequately sealed and the water level inside had been reduced to the top of the stones, men entered the working chamber and poured concrete walls 20-in. thick against the slotted concrete slabs to more effectively seal and strengthen the chamber. The surfaces of the caissons were then hacked with pneumatic chisels; the short lengths of reinforced bars, or stickers, already cast in the walls for the purpose, were straightened out, and then the whole of the working chamber, with the exception of a small working space in the line of the shaft was filled in with concrete as shown cross hatched. Thereafter the stones were again extracted to a depth of about 2 metres to again form a working chamber floor. The same forward procedure was carried out in a series of 2 metre flights until the rock floor was reached and an adequacy of penetration effected. It was found that the more satisfactory procedure on reaching the rock stratum, if of uneven nature, was to build a brick wall in rapid setting cement mortar rather than cast it in concrete. The methods and the technique employed proved highly satisfactory; few mishaps occurring.

Stability of Caisson Walls.

It was foreseen that the reduced and uniform width and greater free height of the caisson walls in the first stage of construction would impose greater stresses than would be the case in the designed

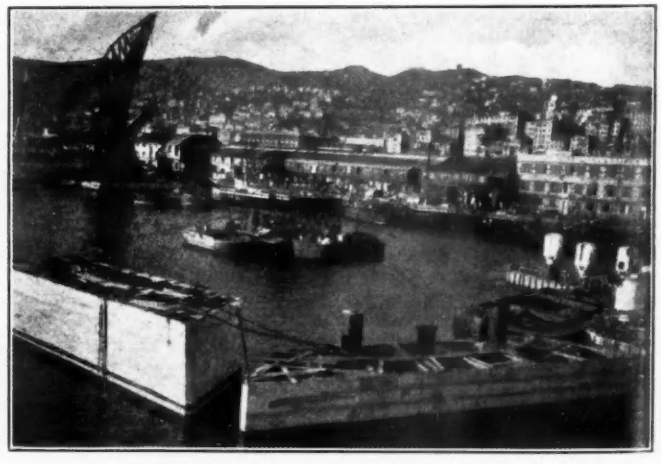


Fig. 3. A photo of the first three caissons sunk in place and one to the left is still afloat. In the middle there is a mobile pontoon carrying steel caisson and air compressor equipment which is used for preliminary levelling of foundations prior to the sinking of R.C. caissons.

No. 4 Dry Dock, Genoa—continued

finished section, when the entrance would be sealed by the gate and the dock exhausted of water. Provision was therefore made to insert sturdy T beam struts of reinforced concrete 20 m. long between opposing transversal units at about 1 m. below water level, and also to cast a partial concrete floor or traverse between the opposing bases (Fig. 5). Thus it was considered of importance that expert mathematical analysis should be made of the structure acting as cofferdam. Professor G. Krall* undertook this task.

In these calculations it was imagined that the total pressure of the water on the face could be considered as resisted by the structure in a combination of two ways (a) as a cantilever fixed at the foot and (b) as a horizontal arch transmitting the thrust to the transverse counterforts or buttresses. On this hypothesis the portion acting on the wall considered as a cantilever can be expressed as

$$p_1 = p_o \left(\frac{x}{h}\right)^m \left[\frac{1-\cos\frac{2\pi y}{\phi}}{2}\right]$$

where x = depth of the point at which the pressure p_1 acts.
h = the maximum depth.
y = the horizontal distance of the point from the external face of the counterfort.
l = the distance between two consecutive counterforts.
m = an unknown which is to be determined together with the other unknown constituted by the force r according to the above conditions.

Whilst the portion sustained by the cantilever transmits no pressure to the counterfort it takes its maximum share between two contiguous counterforts and so adds also proportionately to a given power m, increasing as the point about which it has to be determined approaches to the foundations. With the aid of graphical representation of the two functions, determining the assumptions of the cantilever and the arch action respectively for various values of m in the point of meeting, it was found that m = 6. With that value inserted in the expressions it was determined that the resultant force was 900 tons for a depth of foundations of 20 metres.

To check the validity of the mathematics Professor Krall used photo-elastic models which were contrived by three pieces of celluloid, instead of five (1 long representing the wall arch unit, two for the transverse units and two for the joints). He also used a model in one single piece with the two ends of resin, a material approximating to a non-tensile quality. To these models he applied weights up to 600 kgs., a force proportionately greater than in actuality, to the face representing the external wall. The isostatic and the isoclinal lines were thus traced. From the examination of the isochromatic lines it was established that the specific pressure at the lower corner corresponding to the inside of the springing was about 5 and in the middle of the arch about double the value of the upper corner. This gave a mean inclination to the base of the isostatic line of 110 : 100 on the face normal to the caisson (which is actually on the horizontal section).

From this one can calculate the normal force N transmitted to the springing by the longitudinal unit taking the loading p = 1 and taking into account that the length of the long caisson compressing the joints is 22.50 m., thus,

$$N = 22{\cdot}50 \times \frac{110}{100} = 24{\cdot}75 \text{ tons}$$

for every ton of loading p.

From the direction of the stress and the proportions established above, for stability.

$$\left(\frac{\sigma + 5\sigma}{2} - \frac{2\sigma}{3}\right) \triangle = N$$

where

σ = the minimum stress at the outer corner.
$\triangle$ = the thickness at the springing (joint).

* "Analysis of the Construction of No. 4 Dry Dock, Genoa," Annali di Lavori Pubblici, November 1935, Vol. XIV, No. 11.

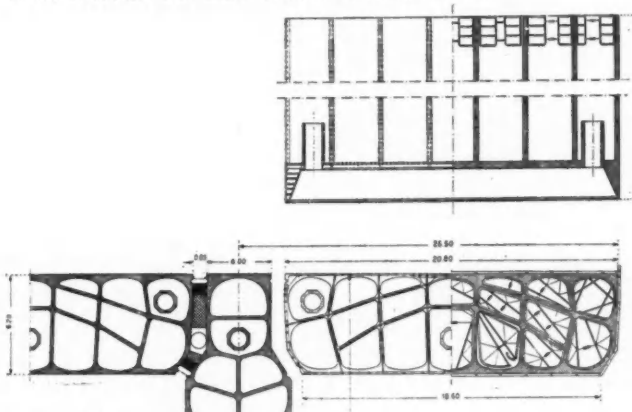


Fig. 4 (above). Part detail of caissons and joints, showing the cellular construction: the arched form of the ribs of wall unit; to the right the method used for collapsible internal shuttering and reinforcement: the positions of access shafts to air working chamber: the concrete filling in the joints, the darker hatching being placed first to seal chamber.

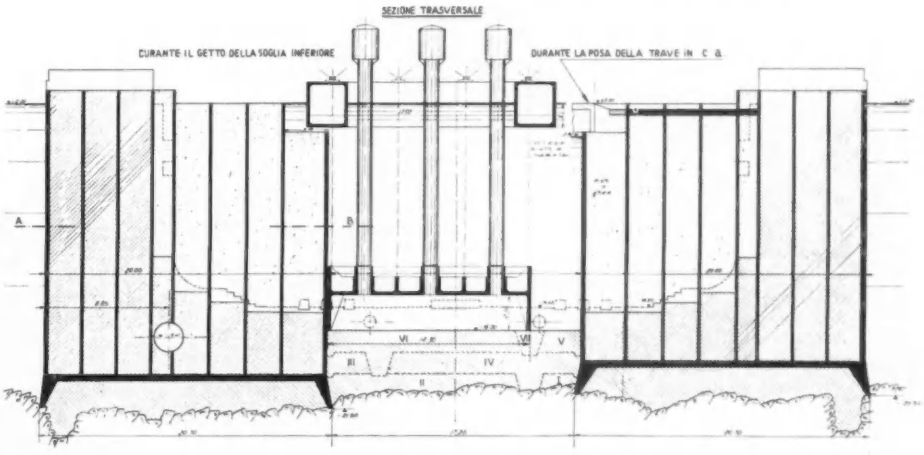
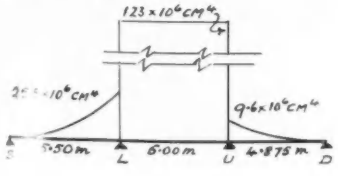
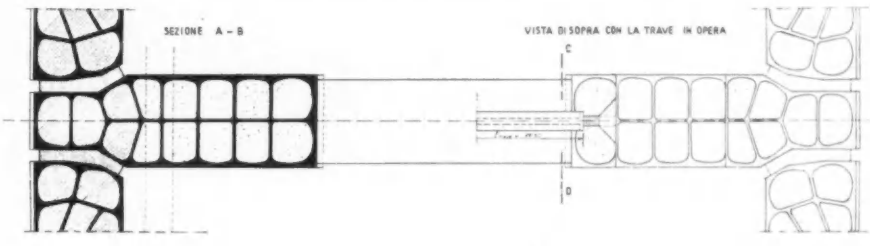


Fig. 5 (right). Cross-section through the transverse caissons showing the method of construction of traverses on rock bed between the units and the seating of the strut beam at W.L. The outline of dock cross-sectional profile shows the portions of caissons to be demolished subsequently. In these portions the cells were filled with gravel and sand.

Fig. 6 (below). Diagrammatic beam analogy of entrance gate Modulus of inertia. S = sill, L = lower beam, U = upper beam, and D = top deck of gate.





No. 4 Dry Dock, Genoa—continued

Then the maximum unit compression is

$$\sigma = 3/7\ (N/\Delta) \times 5\ p_{max}$$

The term p_{max} is calculated on the assumption verified by the above expression of the stability of the wall, which may be expressed as we have seen as an arch key block

$$p\ (x/h) = p_o\ [x/h - (x/h)^6]$$

where $p_o = h\gamma a$

executing the differentials of p and equating to zero, it is found that p max is at the depth x=0.699h, and therefore by a simple calculation taking Δ, the thickness of the joint for equal safety, at 1.15 m. (3.77 feet), it is seen that σ=67.06 kgs. per square centimetre (952 lbs. per sq. in.). The high value of this stress although not entirely unexpected caused the engineers to make provision for an increase in the width of springing, by filling in

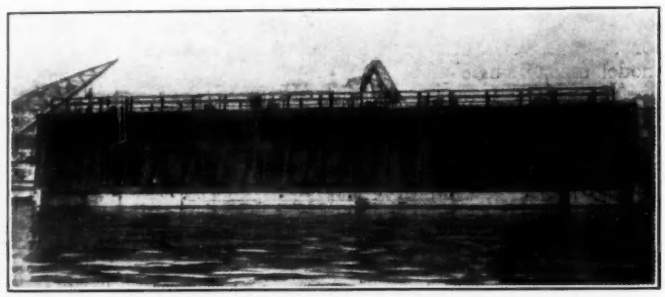


Fig. 7. The floating entrance gate lying near dock basin, showing the six sluice gates above upper beam deck used for flooding the dock. The water cascades down like a waterfall and therefore preliminary filling to cushion the shock on apron is provided through pump house pipes.

the gap on the internal face with concrete when the time should come to pump out the dock, which would be done little by little.

Traverses.

All calculations were based on a foundation depth not exceeding 20 m. Actually the rock bed was greatly accidented, ledged and traversed with deep fissures and clay tongues, indeed during working the compressed air could sometimes be seen escaping through the rock surface 40-ft. away from the chamber. Depths up to 25 m. (82 feet) were frequently excavated and in a few instances 27 m. (88.5 feet) inside the working chamber to reach solid impermeable rock. At times the circumstances caused anxiety about the stability of the walls when the time arrived to pump out the water from the basin for the construction of the dock floor.

As already referred to the construction of a concrete traverse on the sea bed between opposing transversal units was considered highly necessary. To effect this a mobile pontoon caisson plant was used (Fig. 5). As this was not ample to span the whole length a second smaller compressed air caisson was brought into use. This submerged traverse had the same width (6.50 m.) as the transverse units on the plane of the foundation and a minimum depth of 4 m. from level −16.00 to the rock of the sea bed. The procedure of pouring the concrete in the working chambers of the caissons is shown by the Roman numerals.

To construct the sill and the apron of the entrance gate a steel fabricated caisson suspended from a R.C. pontoon was also used. The same method of extensible shafts to air locks, and extensible suspension rods, were employed as those shown in the illustration. As the caisson dimensions were 14 m. by 8 m. two placings were required to secure the width necessary.

The vertical external seatings and grooves for the gate were executed in the open, inside the vertical cells of the specially designed dock head units. Later the head caisson walls were demolished by divers.

Analytical Investigation of Entrance Gate.

As in the previous calculations carried out by Professor Krall they start from the concept of the composition of the structure in two systems superimposed; one, that is to say, constituted by the upper beam, not just by the resisting vertical members, considered as though divided in so many strips, supported only at the upper beam and on the seating of the lower sill (without support on the intermediate beams) submitted to all the external loads and to all the unknown reactions of the intermediate beams; and a second system constituted by the intermediate beams each one submitted to the said unknown reactions. They must result in the sum equal to the loads in every point of the vertical members and of the intermediate horizontal beams (Fig. 7).

The variation to the more usual method of calculation applied by Professor Krall consists in assuming that the reactions of the intermediate beams are distributed in a uniform loading rather than concentrated in the points of intersection with vertical beams according to a function of the horizontal distance x from one end developed in Fourier series.

In the case of one single intermediate beam, let p represent the said function, then

$$p_1 = p_o + \Sigma\, p_n \sin \frac{n\pi x}{l}$$

where l=the theoretical span of the beam, that is the width of the entrance gate measured between the centre lines of the seating of the lateral supports, and

$$p_o = \delta_o / c$$

$$p_n = 1/n^5\ \frac{4/\pi\ \{p_s\eta - (I/I_1 + \eta^2)\ p_o\}}{(h/l)^3 \left(\frac{I}{l\ I_v}\right) \pi^4\ v + \frac{1}{n^4}\ (I/I_1 + \eta^2)}$$

$$n = (1, 3, 5 \ldots .)$$

where δ_o = the deflection corresponding to the said beam of a generic vertical strip of unit width sustaining the hydrostatic pressure when the upper support is assumed fixed.

c = the deflection which in analogous conditions the horizontal force P=1 produces in the vertical strip corresponding to the intermediate beam (assuming this latter suppressed.

$\eta = h_1/h$ = the ratio between the heights of the intermediate beam and of the upper beam above the sill respectively.

I and I_1 = the moments of inertia of the upper beam and the intermediate beam respectively.

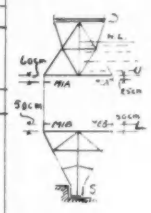
I_v = Moment of Inertia (maximum) in the vertical ribs, which have a variable M of I.

V = the defleciton of a beam of length 1, modulus of elasticity 1, moment of inertia variable in the same ratio as the vertical beam, subjected to a force 1 in point corresponding to the intermediate beam assumed suppressed.

$p_s = \frac{H^3\ \gamma a}{6h}$ = the reaction on the upper beam due to the hydrostatic pressure always assuming the intermediate beam suppressed.

GAUGE READINGS						LENGTH CHANGE 200kg/sq.cm = 1.57mm GRAPH ORDINATES			
DATE	WATER LEVEL	POSITION ON GATE MIA	MIB	MEA	MEB				
8.12.38	EMPTY	384	385	371	405	+47	+64	-52	-54
9.12.38	-3.0m	371	364	392	428	+34	+43	-31	-31
W. L.	ZERO	MEA	MEB	MIA	MIB	337	321	423	459
11.1.39	-1.0	325	306	434	469	-12	-15	+11	+10
12.1.39	-3.0	305	284	457	489	-32	-37	+34	+30
18.1.39	-4.4	295	267	473	502	-42	-54	+50	+43
	-5.5	287	261	474	506	-50	-60	+51	+47
26.1.39	-6.7	284	257	478	508	-53	-64	+55	+49
26.1.39	-7.9	279	254	481	512	-58	-67	+58	+53
29.1.39	-9.25	277	247	491	521	-60	-74	+68	+62
31.1.39	-10.50	276	245	499	525	-61	-76	+76	+66
6.2.39	EMPTY	279	242	513	533	-58	-79	+90	+74

GATE REVERSED



THE DOT ABOVE FIGURES = TENSION

Fig. 8. Table of deformation measurements on the entrance gate during the emptying of No. 4 dry dock, taken at the positions shown on diagram of gate section.

No. 4 Dry Dock, Genoa—(continued)

The above expressions have so far dealt with the hydrostatic pressure only, whereas in the actual floating vessel forming the entrance gate, when the dock is emptied of water and the inside skin of the gate is open to the sky, there is a thrust on the external water-borne portion of the hull due to the buoyancy forces which are necessarily eccentric and produce moments of torsion in the structure. This then requires the corrections Δp_0, Δp_n, to be added to p_0 and p_n, which on the other hand may be arrived at by adding to the term p_s the value $\Delta p_s = m/h$ where m is the twisting moment and h is the height of the upper beam above the lower seating.

Applying the actual dimensions of the entrance gate to the above argument, we have,

$$H = 13{\cdot}775 \text{ m}\,;\ h = 10{\cdot}50 \text{ m}\,;\ h_1 = 5{\cdot}50 \text{ m}\,;$$

$$\eta = \frac{5{\cdot}50}{10{\cdot}50} = 0{\cdot}524\,;\ \eta^2 = 0{\cdot}2746$$

$$l = 40{\cdot}90 \text{ m}\,;\ \gamma\alpha = 1{\cdot}03 \text{ tons per cu. m.}$$

$$p_s = \frac{(13{\cdot}775)^3 \times 1{\cdot}03}{6 \times 10{\cdot}50} = 42{\cdot}733 \text{ tons per lineal metre}$$

$$\frac{H^2\,\gamma\alpha}{2} = \frac{13{\cdot}775^2 \times 1{\cdot}03}{2} = 97{\cdot}722 \text{ tons per lineal metre}$$

The ratio I/I_1 has been assumed *a priori* equal to 1.4 in accordance with analogous ratio of the beams of the floating gate of No. 3 dry dock therefore we have

$$I = 250 \times 10^6 \text{ cm}^4, \text{ and } I_1 = 180 \times 10^6 \text{ cm}^4$$

The moment of inertia of the vertical rib, required to determine the quantity c, is variable and is approximately as shown in Fig. 6. Solving graphically as a continuous beam with the three fixed supports taking into account the variability of the moments, one finds that the reaction of the intermediate beam is

$$p_0 = 71{\cdot}358 \text{ tons}$$

and V = 1/7·78 and hence

$$p_1 = \frac{1{\cdot}2732\ \{42{\cdot}733 \times 0{\cdot}524 - (1{\cdot}4 + 0{\cdot}2746)\ 71{\cdot}358\}}{\left(\frac{10{\cdot}5}{40{\cdot}9}\right)^3 \left(\frac{250}{40{\cdot}9 \times 123}\right) \frac{97{\cdot}3364}{7{\cdot}78} + (1{\cdot}4 + 0{\cdot}2746)}$$

$$= -72{\cdot}7465 \text{ tons per lineal metre}$$

similarly

$$p_3 = -12{\cdot}3107 \text{ tons per lineal metre}$$

$$p_5 = -1{\cdot}4349 \text{ tons per lineal metre}$$

For the twisting moment corrections one has

$$m = \frac{3{\cdot}25^2}{2} \times 5{\cdot}00 \times 1{\cdot}03 = 27{\cdot}1984 \text{ tons per lineal metre}$$

$\Delta p_s = m/h = 2{\cdot}5903$ tons per lineal metre
$\Delta p_0 = -4{\cdot}5647$ tons per lineal metre
$\Delta p_1 = +6{\cdot}7560$ tons per lineal metre
$\Delta p_3 = +1{\cdot}1432$ tons per lineal metre
$\Delta p_5 = 0{\cdot}1333$ tons per lineal metre

Once having noted the p_n and the $\triangle p_n$ it is easy to calculate the distribution of the loads on the upper beam designating in general $q = p + \triangle p$

$$q(x) = q_s(x) - \left\{q_0 + \Sigma\, q_n \sin \frac{n\pi x}{l}\right\} \eta$$

where x is the abscissa starting from an end, or rather from the seating towards the centre and knowing the distribution of the loads on the upper and lower beams one readily computes the maximum bending moments which in this case amount to 7,914 tons/m for the upper beam and 2,981 tons/m for the lower beam at the centre of the truss.

The allowed safe working stress for the steel members was 16 kgs. per mm.² (10.16 tons per sq. in.) and for iron 7.6 tons per sq. in. A deformation test was made on the floating gate on site when the dock was emptied in the following manner. At exact distances apart of 50 centimetres on the hull of the gate registered screw plugs having at their heads holes to receive the point of a deformation meter, fitted with vernier, were fixed. The vernier attachment was made to measure variations in length of one four hundredth of a millimetre. That is to say, as the plugs were 50 cm. apart 1/400 mm. would represent extension of 1/200,000

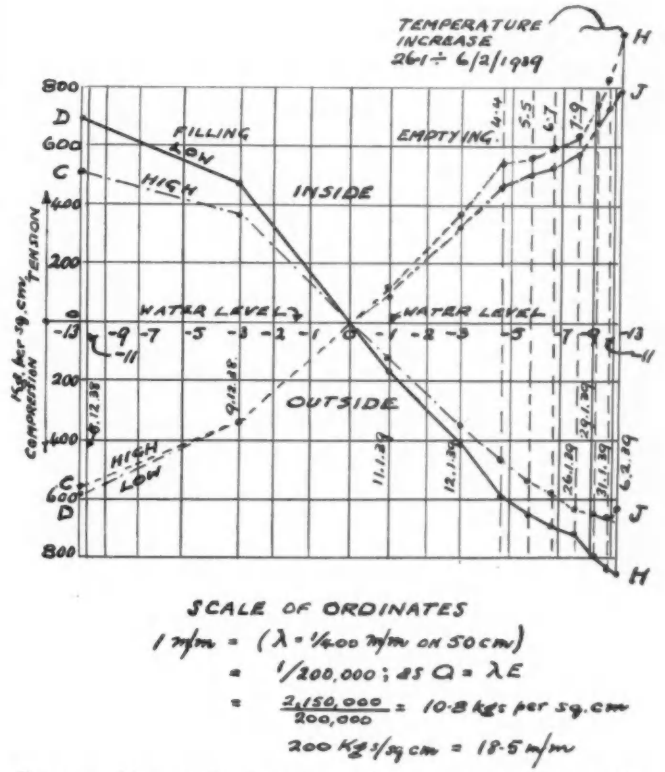


Fig. 9. Diagram showing stresses in material of entrance gate corresponding with hydrostatic heads as given in Fig. 8.

and taking modulus of elasticity at 2,150,000 tons, one point on the vernier would represent a stress of $\frac{2{,}150{,}000}{200{,}000} = 10.8$ kgs. per sq. cm., or 153 lbs. per sq. in.

The results obtained on the emptying of the dock on February 6th, 1939, showed that the stresses were not greater than those allowed in the design, that is 10 kgs. per mm.² notwithstanding that in the last day of emptying there was a considerable increase of temperature. Several other confirmatory tests were made as the following demonstrate.

The table Fig. 8 gives the date on which the measurements were taken; the water level at the time is in the second column, the zero depth is when outside and inside of the dock the water surface is equal, when the water inside is below sill level the dock is empty. The four columns grouped under position on gate indicates the reading of the vernier when the deformation meter is used to measure the registered plug spacings in the positions of the upper and lower beam as shown in the small diagram to the right of the table. The remaining four columns under the group heading of Length change give the difference between the readings in the first group and the standard measurements (unstressed) shown blocked by thick lines. This difference is given in vernier graduations and can be converted into kilograms per square centimetre using the scale given.

From this table the graphs of Fig. 9 are plotted for the upper beam and the lower beams, the curves C D having reference to the filling of the dock, and the curves H J refer to the gradual emptying of the dock.

(to be continued)

150th Anniversary of Southampton Harbour Board.

To mark the 150th anniversary of its foundation, Southampton Harbour Board have issued a well-illustrated brochure, divided into historical and modern sections, the latter depicting the present-day activities of Southampton with details of tide levels, depths of approaches, docks, buoyage and lights, etc.

Ship Stowage*

By LEON C. MUNSON
District Manager, Pacific Transport Lines.

That the ability to stow goods skilfully and properly is an art, which is generally acquired only after a considerable period of experience with many types of cargo, will readily be attested by anyone who, afloat or ashore, has had intimate contact with the operation of ocean-going vessels. Those in charge of stowing a ship must take a number of factors into account. These include stowage of the cargo so the vessel will carry the maximum volume and weight under prevailing circumstances; stowage to prevent damage to the cargo; stowage to prevent injury or danger to the ship or the ship's crew; and stowage that will permit the cargo to be unloaded with the least possible delay at the port or ports of discharge.

The responsibilities and liabilities of the shipowner with respect to the handling, loading, and stowage of cargo are defined primarily in the United States Carriage of Goods by Sea Act, 1936, and the Harter Act of 1893.

According to a ruling handed down by the Circuit Court of Appeals (2nd Judicial Circuit) in March, 1940, neither a vessel nor its operator can be held liable if goods offered for shipment are not cased or wrapped in a manner to withstand the ordinary hazards of an ocean voyage, always providing that such cargo has been stowed with usual care in accordance with the prevailing practice.

Importance of Correct Methods

The methods employed in receiving and handling cargo at the ocean terminal are of the utmost importance to the ocean steamship operator and, under normal conditions, may play a large part in determining whether or not his ships operate at a profit. To the shipper, the handling of cargo in dock and during the loading and stowing operations is also of importance. If the dock force is well trained and the equipment used in handling goods in dock is of the proper kind, there is less likelihood of damage.

In most cases a qualified marine surveyor is employed to inspect the vessel's holds and decks to see that they are clean and dry, properly dunnaged and in all readiness to load cargo; after loading, he issues a surveying report certifying that the cargo has been inspected and that the ship is in a well-trimmed and seaworthy condition.

The efficiency of the dock force, including the stevedoring organisation and the ship's officers, and the care with which their work is planned and carried out, determines in large measure the number of days and hours a ship remains in port discharging inbound cargo and loading outward cargo. For successful operation the ship's time in port, must be, of course, as brief as possible. This is partly because all the major items of expense, with the single important exception of fuel, continue day in and day out whether the ship is at sea or in port. The crew's wages, the officers' salaries, and subsistence for the ship's company represent major operating expenses that must be paid for every day.

In addition to handling cargo intelligently and rapidly so as to eliminate all unnecessary delays in discharging and loading, the dock force must be trained to handle cargo skilfully and with care so that it will not be damaged during the time it is in dock or during transfer to the vessel. Damage claims payable by the shipowner or operator owing to negligence on the part of his employees can amount to large sums during the course of a year.

An accurate tally must be kept of the cargo loaded into the ship to be used for the preparation of final stowage plan, and also to serve as a reliable source of information for the ship's officers when the various discharging ports are reached.

The proper use of dunnage is an integral and essential part of the process of stowing cargo and, because many cargo claims arise from faulty dunnaging or lack of sufficient dunnage, the general principles of good dunnaging must be understood by every officer of the ship as well as by the dock personnel.

Ordinarily the term dunnage is used by American shipping men to refer chiefly to planks and pieces of wood which generally consist of pieces of lumber 2-in. x 8-in. or 2-in. x 10-in. in random lengths.

Dunnage is used for the following purposes, which vary in accordance with the type of cargo: (1) To prevent the movement of cargo and chafage, by chocking off and securing containers and by filling in broken stowage or spaces which cannot be filled by cargo; (2) to protect cargo from contact with water overflowing from bilges or double-bottom tanks, and from leakage from other cargo.

It is not possible to lay down hard and fast rules which will apply to the dunnaging of all cargos, all ships, or all voyages; but there are certain principles which, if borne in mind, should be of assistance to those who are responsible for the dunnaging and stowing of cargoes. For example, bear in mind the fact that the onus is generally on the ship to provide sufficient and suitable dunnage to prevent damage to cargo. The dunnage must, therefore, be not only able to stand up and serve its purpose under ordinary conditions, but, insofar as possible, provisions must be made for any untoward eventualities or circumstances that may occur during the voyage. No precaution is too great to take, for example, to prevent heavy packages from crashing against other cargo or against the frames and plates of the ship.

Some commodities are customarily, and others are occasionally, carried on deck, generally at the risk of the shipper. When stowing a large amount of cargo on deck, care must be taken not to block off bitts and fairleads, the sounding pipes to the bilges and ballast tanks, the handles of the valves controlling the opening of watertight bulkheads or of piping systems, or any other pieces of equipment essential to the operation or safety of the vessel.

A Typical Example

Probably the simplest and best way to make clear the factors to be considered by the individual in charge of stowage is to describe the actual stowing of a ship of average size with a typical cargo of United States export products.

Assume the ship to be an oil burner with five holds and a total dead-weight capacity of 10,700 tons. From this must be deducted, say, 2,000 tons for fuel (for the round trip), 300 tons for fresh water and 200 tons for ships stores and dunnage. This will leave a cargo capacity of 8,200 tons weight and, say, 460,000 cubic feet bale measurement. The cargo booked for his vessel is, let it be assumed, as follows, of which 20 per cent. was deducted from the measurement for loss in stowage.

Commodity	Tons	Cubic feet
Steel	2,000	24,000
Borax in bags	600	30,000
Cotton in bales	2,500	250,000
Machinery	400	28,000
Various Pet. Products in drums	1,000	50,.00
Tallow in drums	500	25,000
Automobiles	100	15,000
General Cargo	1,100	55,000
	8,200	477,000

It will be noted that this vessel has 460,000 cubic feet of bale space below deck and, since the cargo will require 477,000 cubic feet, it will be necessary to stow 17,000 cubic feet of the drum cargo on deck.

Ordinarily, after the holds have been dunnaged, a considerable part of the steel and heavy weight cargo would be the first cargo to be loaded. Inasmuch as they are heavy cargo it is customary to stow them in the bottom space. However, too much weight must not be put in the bottom since a low cenre of gravity would give a ship the tendency to roll which might easily prove dangerous.

Now the real problem begins. Some of the commodities listed as general cargo can not be put in the same hold with the petroleum products, due to contamination, nor can cotton be stowed with petroleum products. Therefore, great care must be exercised in the stowing so that the various commodities can be handled and discharged at destination.

It must also be borne in mind that in many foreign ports vessels anchor inside breakwater and the cargo is discharged to lighters. At the same time loaded lighters come alongside for loading. This procedure must be taken into consideration by the dock force at the loading port in the United States in order to avoid serious delay during the voyage.

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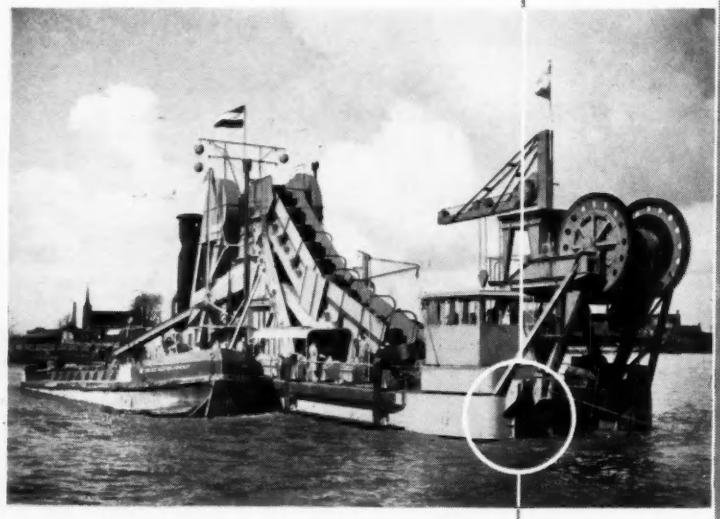

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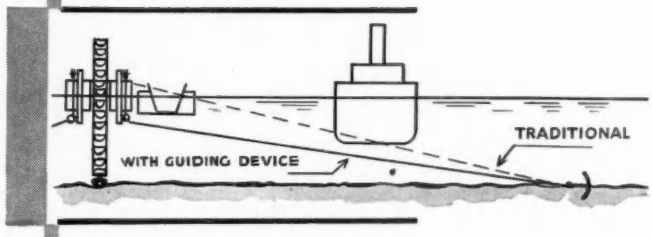

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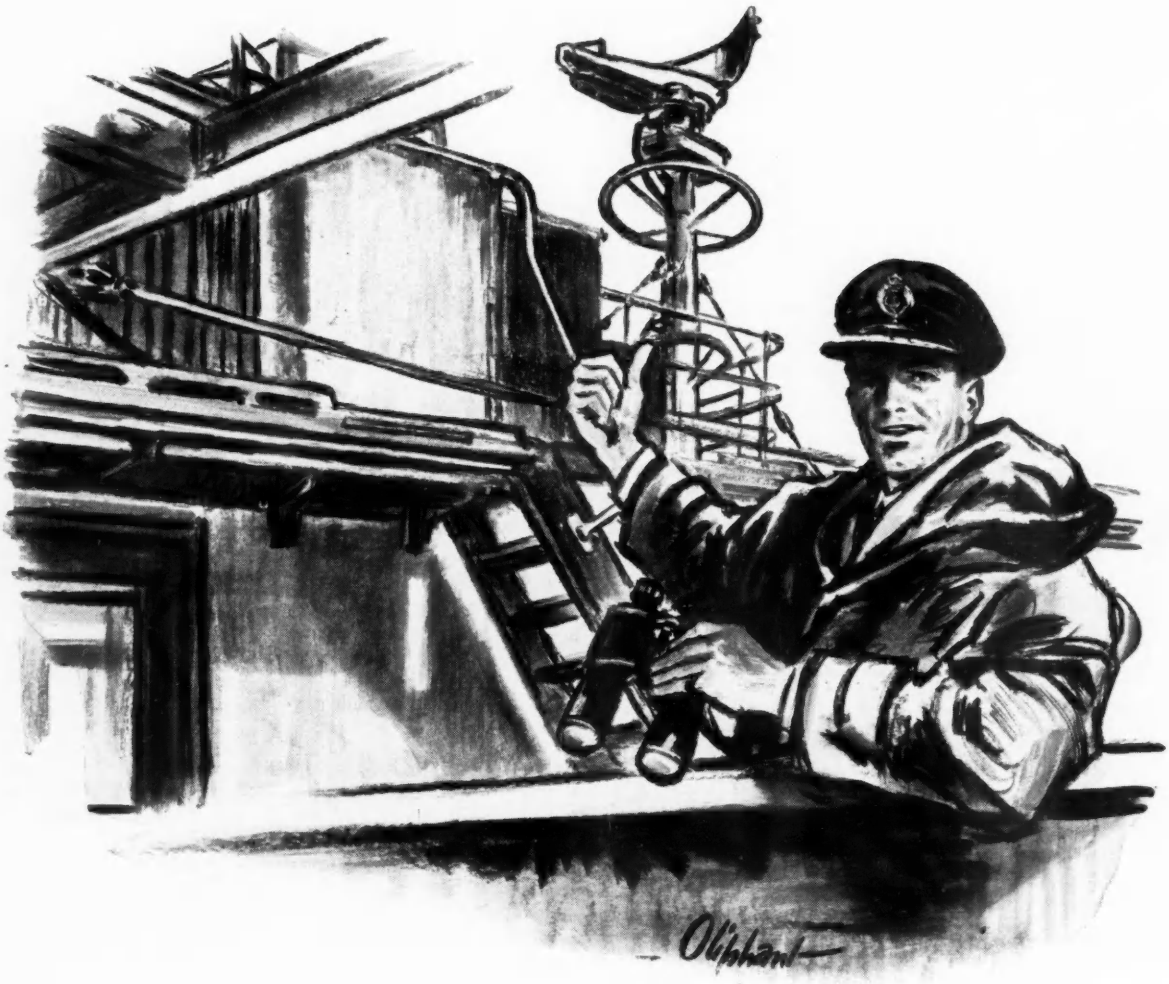

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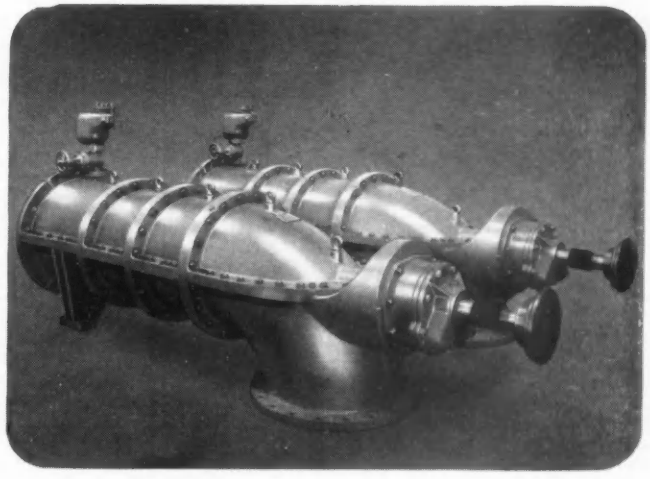

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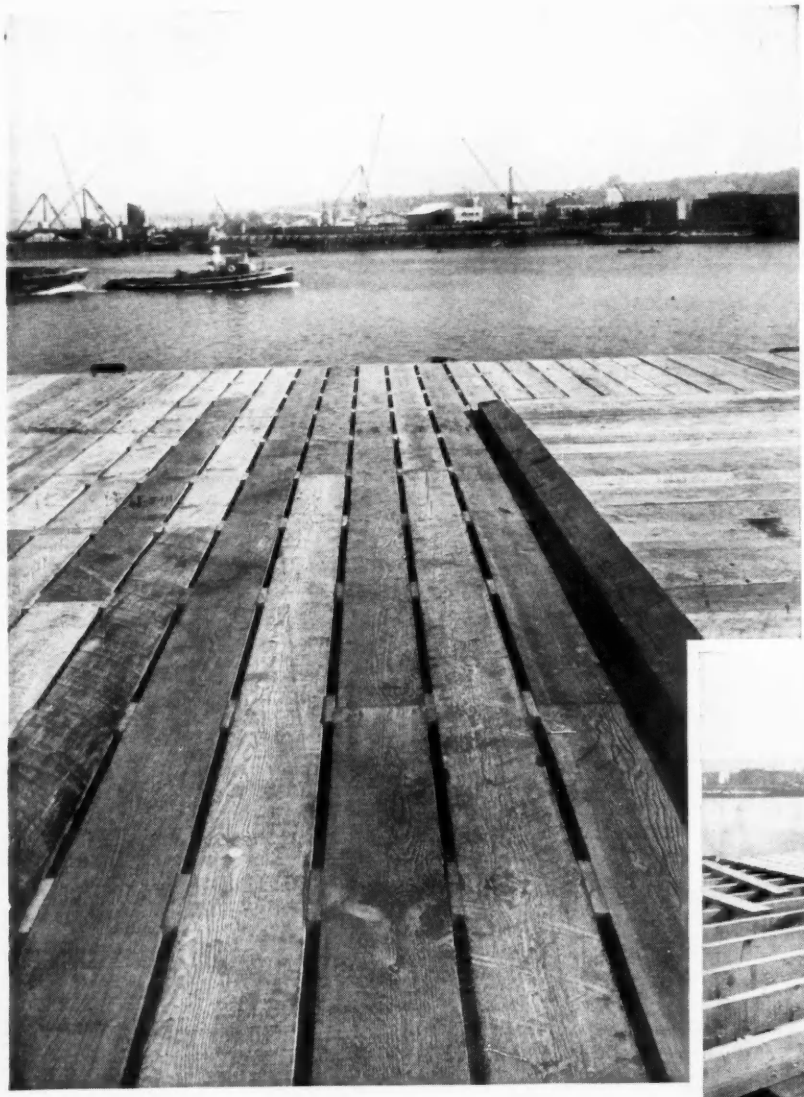

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Oscillations of the Sea and the Phenomenon of Range

Part 5. Origins of Range Action: Storm Centres at Sea

By B. W. WILSON, D.Sc., C.E. (Illinois), A.M.I.C.E., Assoc.M.ASCE., A.M.(S.A.)I.C.E.

(concluded from page 151)

Waves Originating from a Released Head of Water in a Smooth Sea.

UP to the present we have considered only the ramifications of Hypothesis (a), advanced towards the end of Part III of this article to explain the origins of Range-action. There remains to consider whether any credence can be attached to Hypothesis (b), which envisaged the possibility of ground-swells being born out of the rapid subsidence of the entrained body of water beneath a travelling depression when the latter is suddenly overwhelmed by anti-cyclones, or for other reasons is arrested in its normal progression or development.

It has often been noticed that just at the time that depressions are within closest range of Cape Town, the barometric pressure at the Cape suddenly rises instead of reaching new low levels as might be expected. This could result from the depressions encountering colder air-masses in the region south-south-west of the Cape, where their centres of pressure are markedly and suddenly weakened. The question that now confronts us is what happens to the elevated body of water in such a set of circumstances.

One factual clue lies in an observation of Cornish's concerning the tidal bore on the River Trent in England. He observed the bore advancing in shallow water as a single wave or wall of water, but, upon this entering a region of deep water, it was suddenly transformed into a group of gently rounded swells, whose speed of progression was noticeably less than the speed of the original wave[1].

But Kelvin, again, has solved the plane problem for us theoretically and has calculated the surface profile of the sea after successive, equal intervals of time from an assumed zero time, when the disturbance comprised a single, raised body of water (Fig. 11)[2].

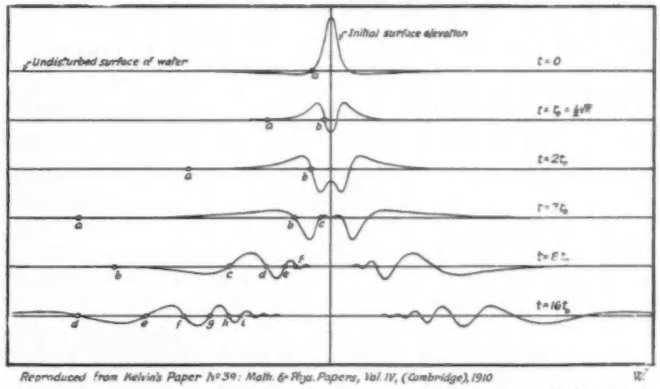
The elevated water-mass collapses and divides into two ever-expanding groups of long waves. The progression of particularly nodal points in the wave-groups can be followed by the code letters a, b, c, etc., in Fig. 11. The sequence of waves is very like what is seen on a small scale when a stone falls vertically into still water and raises a head of water behind it, namely, antecedent long waves diminishing in length to the perceptible ripples on the innermost ring of expanding undulations.

Although a barometric depression covers a vast area of ocean and the surface-gradient of the elevated water-mass is therefore very slight and perhaps on that account unresponsive to wave development, we have to consider the additional factor, not treated by Kelvin, of a general imposition of pressure suddenly applied upon the raised head of water. It seems conceivable that conditions could arise under an exhausting depression under which the same sort of wave-development as traced by Kelvin could be expected to take place, so that disturbances from such a source might reach the South African coast within a comparatively few hours of a sudden rise in barometric pressure.

Sudden Dissipation of Travelling Depressions.

The criterion of such an event taking place would seem to reside in the magnitudes of the rates of change of atmospheric pressure with distance and time at any point of the ocean and at any instant of time. In any direction south of the latitude of Cape Town, barometric pressure can be expected to be less than at Cape Town itself, so that along a radial line in that general direction sea-level has a rising gradient away from the port. The pressure gradient along the radius $\delta p / \delta r$ thus, in effect, represents the tendency that the sea would have to flow towards Cape Town under the influence of gravity, once the holding-power of barometric suction were removed. It is the rate of change of pressure-gradient with time, $\frac{\delta}{\delta t}\left(\delta p / \delta r\right)$ which determines whether this holding-power is altered or not, and the extent of flow in the radial direction towards Cape Town. So long as this quantity is zero no movement will occur, but flow will commence as soon as it is either positive or negative. At some value sufficiently large presumably, propagation will proceed in the form of waves.

Regarding $\frac{\delta}{\delta t}\left(\delta p / \delta r\right)$, then, as a measure of the flow towards Cape Town from any point along a particular radial direction, it seems rational to suppose that the ultimate magnitude of the Range-effect which reaches Cape Town from that point will be inversely proportional to its distance r from the port. (There is no justification for making this inversely proportional to the square of the distance r, as might be necessary when considering emanation from a point source in all directions in a plane surface, since $\frac{\delta}{\delta t}\left(\delta p / \delta r\right)$ is already lineal and pertains only to the particular radial line being considered.) Hence the quantity $\frac{1}{r}\frac{\delta}{\delta t}\left(\delta p / \delta r\right)$ may be regarded as a criterion of the relative capacity of any particular point in the ocean to be responsible for an observed Range-effect at Cape Town. This quantity, of course, is theoretically infinite when r is zero, and strictly speaking, some more appropriate factor than $1/r$ should have been adopted to avoid this, but, so long as we agree to limit application of the expression to radii greater than say 200 miles, it should lose nothing of its generality as a sound empirical index of Range-producing potential.



Reproduced from Kelvin's Paper No 39: Math. & Phys. Papers, Vol IV, (Cambridge), 1910

Fig. 11. Emanation of waves from an initial elevation of the sea.

The application of this expression in any adequate survey of a wide expanse of ocean, for the purposes of locating the area of origin of supposed ground-swells, is necessarily a laborious task, which the writer has had time and opportunity to undertake in only one case. This was the particular incidence of Range-action of June 19/20th, 1945, for which synoptic charts for the South Atlantic were available.

Scrutiny of the synoptic charts seemed to indicate that a radial direction south-south-west of Cape Town would afford the most profitable line of enquiry. This decision was arrived at by plotting first the barometric pressures against the time, separately for several test points such as 200, 500 and 1,000 miles north-west, west and south-west of Cape Town.

Oscillations of the Sea and the Phenomenon of Range—continued

Pressure was then plotted against distance along the S.S.W. radial line for each time for which there was a synoptic chart. The pressure gradients, $\delta p / \delta r$, were measured from these curves and plotted against time in a further series of curves. Extraction of the gradients of these latter curves then yielded values of $\frac{\delta}{\delta t}\left(\frac{\delta p}{\delta r}\right)$ at different times, and these were brought to comparative rating by employment of the factor $1/r$ to give, finally, the required quantities for plotting in the Space-Time Chart of Range-Potential, shown in Fig. 12.

Fig. 12 has been contoured to show the magnitude of the "Range-potential" against a background of distance and time. The positive zones in general indicate flow towards, and the negative flow away from, Cape Town, and closed or semi-closed contours of high potential suggest the times and distances at which this movement was particularly strong.

It is interesting to find that over the period from June 15th to 23rd there are alternating zones of positive and negative potential

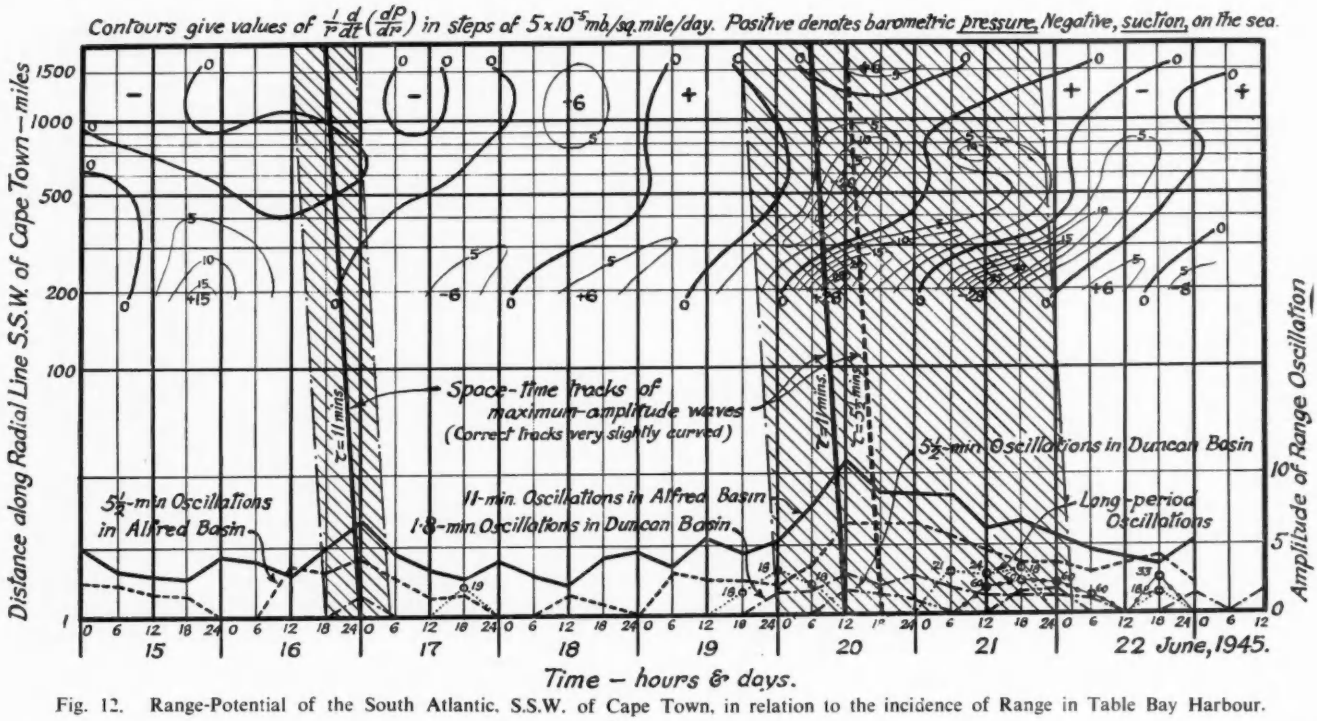


Fig. 12. Range-Potential of the South Atlantic, S.S.W. of Cape Town, in relation to the incidence of Range in Table Bay Harbour.

indicating a roughly periodic flow to and fro along the radial line at intervals of about two days. Some such reversible flow of the sea is clearly necessary to meet the requirements of the rise and fall of the ocean under the travelling depressions and anti-cyclones.

It will be seen that the most likely origins of Range-action in this period occurred on June 15th and 20th at distances of some 200 to 300 miles from Cape Town, when the Range-potential values were respectively 15×10^{-5} and 28×10^{-5} millibars/sq. mile/day. To see whether these accord in any way with the observed effects at Cape Town, which are reproduced from the weather-chart (such as Fig. 4) on the time axis of Fig. 12, we have merely to project, from the centres and margins of these disturbances on the time-base, lines which conform with the speed of progression of long waves over the depths of ocean directly S.S.W. of Cape Town. This final development was suggested by the work of Barber and Ursell (l.c.), who adopted a similar procedure in examining the origins of short-period swells, which travel at group velocities. In their case the space-time tracks of the waves were successfully related to the geostrophic wind speeds in the storm centres.

The velocity of long waves taken as applicable in this case is that given by equation (8) (Part II) and the shaded zone of Fig. 3 (Part II), and the varying depths of ocean over which they must travel have been duly taken into consideration. With the logarithmic distance-scale adopted in Fig. 12, it is found that the space-time tracks of such waves may be represented approximately by straight lines.

If there were any reality in the hypothesis advanced the space-time tracks of maximum-amplitude Range should pass directly through the centres of high Range-potential in Fig. 12. The peak oscillation for this period occurred in both the Alfred and Duncan Basins at about noon on June 20th, and the space-time track of the long waves necessary to cause such a disturbance is found to pass directly through the zone of maximum Range-potential at a distance of some 200 miles from Cape Town. No better tally could really be desired; moreover the general persistence of the oscillations at Cape Town throughout June 20th and 21st accords well with the considerable commotion in the ocean S.S.W. of Cape Town as portrayed by the closed contours of the positive and negative zones.

As against this pleasing congruency, there is a very much less satisfactory tally in the case of the minor peak of Range-oscillation, which occurred at Cape Town at midnight on June 16th. It is, however, what might be called a "near-miss," which could possibly be explained on the basis that the maximum Range-potential for that time occurred on some other radial line, nearly, but not directly, S.S.W. of Cape Town. One feature which supports such a view is that the relative magnitudes of the Range-oscillations for June 16th and 20th are in much the same ratio as the relative values of Range-potential for June 15th and 20th in Fig. 12.

It would require many more worked examples of this kind to prove that the apparent truth of the hypothesis was not just a coincidence. All that can be said is that there is a strong probability that the development of long ground-swells is assisted by the exhaustion of the depressions, as a result of the inherent tendency of the sea to accommodate itself to the prevailing atmospheric pressure overhead. To a large extent this movement will be interwoven with the genesis of high winds, since sudden intensification or dissipation of storm-centres will create the conditions most favourable to the promotion of violent geostrophic winds. This is supported by a general observation that can be regarded as an infallible rule: namely that a Range-action of the higher-frequency type, as distinct from the long-period seiches, never occurs but in the company of prominent, visible swells of short periodicity. Seen in this light, the hypotheses (a) and (b) draw together (at least

Oscillations of the Sea and the Phenomenon of Range—continued

in respect of Range-action arising from storms that do not blow home to a port), and the mutations of travelling depressions as the primum mobile of the Range-phenomenon become common to both.

Compendium of Knowledge on the Origins of Range.

We are now in a position to gather together the threads of extant knowledge upon the subject of the origins of Range-action and its related phenomena. We shall not here concern ourselves with details of the mechanism of this action, except to note that it may be clearly recognised in its simplest form as an oscillation, seiche or standing wave, formed by the passage through each other of two opposing waves of translation. The fundamental requirement for the development of the phenomenon in a sustained form is that there should exist opposing trains of waves of the same periodicity and of nearly equal energy-content; further that these waves should be of a type that will not readily lose energy on meeting a boundary surface in friction and turbulence of breaking. The particular kind of wave that best complies with these conditions is the ground-swell, and this may be defined as any water-wave whose particle-movements at bed-bottom are at least 80 per cent. of the surface-movements. As even the highest-frequency waves become ground-swells in very shallow water, it is clear that our attention must in the general case be turned upon any source whatever that generates waves in water.

It semes that waves in water, and especially ocean-waves, may derive fro many of the following exciting agencies:

(1) Ship movements,
(2) Seismic disturbances,
(3) Meteorological disturbances.

(1) The waves caused by ships when travelling at speed through water, have been shown to include invisible, antecedent swells with periods up to 1 or 2 minutes, besides the more familiar, visible bow-waves and ripples. These long waves precede the ship by considerable distances, and, though feeble, they belong to the persistent ground-swell category: as such, they are capable of generating weak seiches in harbour basins where natural periods of oscillation are of the same order as the incoming waves.

While no positive connection has ever been established at Cape Town (and it must be admitted that it has not been sought), between the embroidery on the marigrams and the movements of ships, it is nevertheless possible that the weak oscillations in the Duncan Basin, often observed at high water in fine weather, are the result of the near approach of large vessels. Out-running tides tend to destroy weak in-coming swells of this nature and the latter register therefore only when tidal flow is favourable to their propagation. Range-action from this source, however, can never be of large proportions, and is really only of passing interest.

(2) More important, but comparatively rare, are the large waves that originate with seismic upheavals, earthquakes, volcanic eruptions and submarine, molar earth-movements. It has been shown that seiches in lakes and large ponds have definitely resulted from earth-pulsations of this kind, and equivalent sea-effects have many times in history been occasioned by submarine shocks or other cataclysmic disturbances.

Seismic sea-waves, near their epicentric origin, are usually huge and overwhelming, and even at remote distances they can still be extremely dangerous. It has often been observed that the advent of waves of this type is marked by an initial recession of the sea, followed by three heads of water at intervals of about 15 minutes[3]. There appears, therefore, to be some natural tendency for seismic sea-waves to be generated always along similar lines.

The only known occasion that waves of this kind have penetrated into Table Bay is that of the eruption of Krakatoa in 1883. It is more than probable, however, that repercussions of distant tremors have from time to time caused seiches in the bay and harbour, even though no clear-cut instance of this sort has been identified in the ten years that the Range phenomenon at Cape Town has been under study.

(3) Of far greater importance because of their greater frequency are the waves deriving from purely meteorological sources, such as cyclones, hurricanes, frontal depressions, line-squalls, winds and air oscillation. Such waves, that draw energy from the atmosphere, are dependent upon the global circulation of air and the inherent tendency for waves of oscillation to be set at the interface of two fluid media (air and water), when these move across each other at different velocities. The very much more mobile atmosphere, in streaming or vibrating over the surface of the sea according to the dictates of hemispherical circulation, induces the oscillation at the surface of discontinuity, known to us as the familiar ocean-wave or coastal seiche.

Wherever wind plays over water, wave-trains are generated in which the most conspicuous wave-periodicity appears to be proportional to the wind-speed and the maximum to be about 4/3 of this predominant one. But purely wind-generated waves of periodicities above about 30 seconds cannot exist owing to the general theoretical and observational condition that speeds of wind-generated waves be always less than wind-speeds (80 per cent. according to Cornish). Waves of higher periodicity than 30 seconds have speeds in deep water exceeding 150 m.p.h. (Fig. 3), which is more than any known wind-velocity.

It has been noticed that when the predominant wind-speed exceeds about 50 m.p.h. there no longer seems to be any restriction upon the maximum periodicity of wave occurring in the resultant wave-train. This suggests that some other factor comes into operation with high winds to extend the scape for generation of long waves and ground-swells, known to accompany wind-generated waves. The most obvious agency is barometric pressure and this introduces consideration of the oscillatory nature of atmospheric circulation.

The atmosphere is known to envelop the world in a series of ellipsoidal, isentropic shells, co-axial with the earth's poles, and the intrinsic resiliency of these layers is responsible for the phenomenon of air-waves. In particular, the large air-waves which form at the polar-front discontinuity between the layers over the hemispherical temperate zones, are the media mainly responsible for weather. The travelling depressions of these regions appear to be the vortices created by the breaking of these eastbound waves along the latitudes where the discontinuity intersects the globe; as such, they are the centres of disturbance over the sea which give rise to the most violent winds and which constitute the most important sources of ocean-waves. Cyclones and hurricanes are less frequent, but more vigorous, examples of the same sort of thing occurring in the equatorial belt, and are more especially to be feared for the seismic-like sea waves they are capable of developing.

Line-squalls, which invariably accompany the cold-front of a travelling depression, are apparently parasitic waves riding on the back of the parent depression-wave. They appear to bear some resemblance to bores in estuarine waters, and run down the cold-front interface to break in gusts of wind and rain on the surface of the earth or sea. The cold-front and line-squalls are definite pressure-surges, which on their own account will induce trains of sea-waves during their forward progression across the ocean. The waves, so engendered, will precede or follow in the wake of the disturbing line of pressure, according as the group-velocity is greater or less than the speed of the pressure wave.

But cold-fronts and line-squalls, which must be rated as long atmospheric waves, are not the only types of air-waves which, barometrically, are capable of influencing the surface of the sea. Evidence can be adduced to show that the travelling depressions are invested with still smaller atmospheric waves, which react on the wind by giving to it much of its intermittent gustiness. The reality of these air-waves is often proved by simultaneous periodic fluctuations of barometric pressure and wind-strength, but the height of the wave-plane and the wave-length of the aerial billows seem to determine whether they will register barometrically at all.

There can, nevertheless, no longer be any doubt but that these quasi-periodic fluctuations of pressure and wind-velocity, when impressed upon the surface of water, induce long ground-swells capable of causing both lacustrine and marine seiches and the smaller vibrations of lake or sea, known variously as scend, surge, run, undulation, surf or Range.

The question of how these ocean-waves would be disposed in relation to the moving cold-front of a depression is of some interest. Here we may note that depressions and their cold-fronts advance at speeds of about 35 to 40 m.p.h., while line-squalls and following winds in the average case pass through them at speeds of perhaps

Oscillations of the Sea and the Phenomenon of Range—continued

45 to 50 m.p.h. On the basis of the observation that wave-velocities tend to be of the order of only 80 per cent. of the wind-velocities, the bulk of the purely wind-generated waves could be expected to have speeds in deep water of the order of 36 to 40 m.p.h., corresponding to predominant wave-periodicities between 10 and 15 seconds (Fig. 3). In deep water these waves would advance with a group velocity only half that of the individual waves, say 20 m.p.h. and would thus tend to lag behind the cold-front. Long waves of periods above about 30 seconds, on the other hand, if induced by barometric oscillations at or near the cold-front, would travel in deep water at the high speeds of ground-swells and would rapidly out-distance the front. As the waves became retarded on a shelving coastline, the cold-front would tend to gain upon them again to a limited extent. We should thus expect to find long waves precursing, and short waves trailing, the cold-front, although this arrangement would not be inflexible, and would depend very largely on where the highest winds and most pronounced barometric oscillations were situated in relation to the front.

We find some measure of support for this conception in the occurrences of Range-action at Cape Town. In three specific cases wherein the storms blew home to the port and the cold-fronts were identifiable, the long-period seiches are found to have preceded the arrival of the cold-fronts by approximate periods of 8, 36 and 24 hours, while the main body of the shorter-period Range-action lagged behind by some 27, 21 and 14 hours respectively. But here it must be remarked that even this sequent Range-action derived from long ground-swells, so that our generalisation of wave-positions with reference to the storm requires qualifying in respect of the likelihood that the main body of ground-swells originates from the depression-centre itself—the hub of activity, which may be many hundreds of miles away from the particular point of the cold-front being considered.

Here we must consider the possibility that a further agent in the development of long ground-swells is the release of the entrained body of water at the core of a depression as the result of sudden exhaustion of barometric suction, and plunger-like action on the surface of the sea from the inrushing anti-cyclone. Some brief study of this aspect with rather limited data suggests that this may be a contributing factor. Ground-swells in this case would be promoted by the gravitational flow of a raised head of water expanding into still water.

We have not yet exhausted the possible modes of excitation of long ground-swells accompanying wind-generated waves, for it appears that they are in any case the necessary accompaniment of a free procession of waves in deep water. Any group of waves, whipped up by the wind, which passes out of the storm area and is left to its own devices to propagate as a smooth swell, will, according to the theoretical predictions of Kelvin, gradually attenuate itself by developing antecedent ground-swells advancing through the group from the rear. Theory shows that this happens also in all the modes of generation of water-waves we have thus far considered, whether it be from wind, pressure-fluctuation, initial surface-elevation or advancing steady pressure.

The pattern of Range-action begins to assume a semblance of uniformity, and the observation that swell always accompanies Range-action fits naturally into the picture we have formed of the affinity ground-swells have for any type of wave propagation. It seems that the visualisation of concurrent influences may not be far removed from the truth, Range-action in any given instance being born of surface-winds, barometric oscillations, advancing aerial bores or billows, and vanishing depressions, all operating together to produce overlapping effects of a similar kind, although each by itself could produce the action independently of the others.

There remains, however, to draw a distinction between meteorological effects which excite powerful long-period seiches in the absence of observable swells from the sea, and those just considered, which are more particularly responsible for the dense embroidery on marigrams. The former has been found at Cape Town to consist of vigorous barometric oscillations, prevalent directly over the coastal area at the time the seiches develop and comparable in periodicity with the induced seiches.

At present no very clear-cut relationship of these barometric oscillations to the weather has been established, but there seem to be some grounds for believing that they may originate from the general mêlée of opposing air currents destroying each other's momentum, or from one depression-wave overtaking and overriding another.

In the case of Table Bay the development of these seiches appears to be dependent on a north-westerly drift of the atmosphere overhead and it is likely therefore that extremely long waves enter the bay from the open ocean in addition to the forced waves created directly under the air-disturbances.

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2 "Initiation of Deep Sea Waves of Three Classes", Math. & Phys. Papers (Cambridge), 1910, Vol. IV, Paper No. 39, pp. 419-438.

3 Cf. Green, "Seismic Sea Wave of April 1, 1946, as recorded on Tide Gauges", Publicn. U.S. Coast & Geodetic Survey, San Francisco, Calif., p. 4.

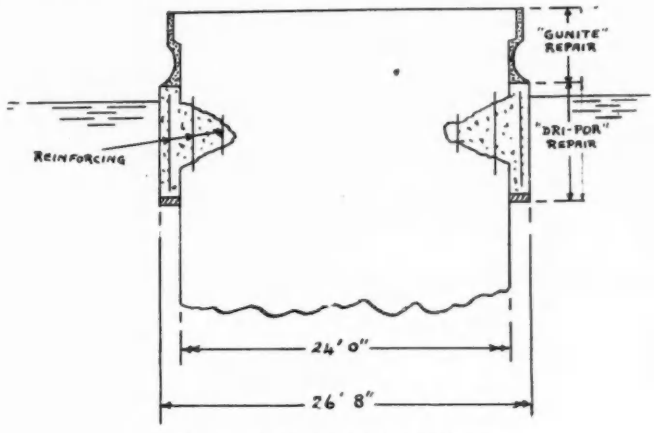
Underwater Concrete Repair

New System Adopted in the U.S.A.

By I. LEON GLASSGOLD.

Recently the 24-ft. diameter concrete pier supporting the Baltimore and Ohio Railroad swing span over Bear Creek near Baltimore, Md. was repaired and encased "in the dry" for an average depth of 6-ft. below mean low tide. Utilising "Dri-por" underwater repair techniques and working closely with railroad engineers, the contractor devised a construction plan that successfully solved this complicated repair problem.

Previously, the railroad company had carried out a sub-surface inspection by diver which indicated that between mean low and mean high water, deterioration varied anywhere from 12-in. to 48-in. deep around the pier. Plans were then drawn indicating a



Sketch showing nature of repairs.

general approach to the problem with the procedure for repair (see sketch) established as follows:—

(1) Fabricate a wrought iron circular form 16-in. larger in diameter than the pier which would be used both as a cofferdam and concrete form.

(2) Erect and seal this cofferdam around the pier so that its bottom plate would be about 30-in. below the lowest point of deterioration.

(3) Tremie a 12-in. layer in the bottom of the cofferdam to provide a concrete seal so that the cofferdam could be dewatered.

(4) After the seal had set, dewater the cofferdam and remove all deteriorated concrete with pneumatic chipping hammers. Place reinforcing steel and fill the cofferdam with a high strength air entrained concrete leaving the wrought iron cofferdam-form in place as permanent part of the pier.

A review of the above four items will indicate immediately the sound engineering principles behind the repair work, for example:—

Underwater Concrete Repair—continued

Firstly, doing all work " in the dry " allows for visual inspection, removing disintegrated concrete, completely and thoroughly welding all reinforcing and eliminating guess work during the pouring of the concrete. This flexibility in the character of the repair work is impossible with other prevalent methods and procedures.

Secondly, leaving the form in place and making the encasement about 16-in. larger all around will probably more than offset its cost in longer service life for the pier.

Generally speaking, the aforementioned construction procedure was followed by the contractor except for the tremie work. He eliminated this item and elected to effect " Dri-por " type seals which were designed to keep the cofferdam dry at all times.

With the general procedure set, numerous problems akin to those ever present in all construction work presented themselves during the preliminary planning stages. The major difficulty was the fact that the swing span had to be opened for water borne traffic quite frequently. The use of heavy floating equipment which would have facilitated cofferdam erection was out of the question. Consequently the cofferdam had to be broken down into small sections for hand erection. This type of fabrication, of course, increased the number of possible points of leakage.

Even the hand erection procedure was hampered because the actual working space between the water (M.L.W.) and the swing span was only 6-ft. and the cofferdam was 8-ft. in depth. To circumvent this problem the erection had to be done during low tides or at least low enough to work on the lower portion of the cofferdam. In addition, the cofferdam could not be suspended from the swing span since the span had to be free to allow water traffic to get through. This necessitated the design of special hangers and jacking procedures for setting the cofferdam in place.

Finally, a last and vital problem was that of pouring the concrete. The nearest shore was some 800-ft. away and accessible by rail or water only. Because of wind vagaries and other circumstances, the water route was rejected as hazardous and uncertain. The simplest procedure using rail was to load the trucks on a flat car and haul them to the site where they would deposit the concrete directly to the forms. The ready mix contractor rejected this plan so that an alternate method requiring a railroad crane had to be used.

With these problems temporarily solved, the cofferdam was fabricated and erected and match marked by the railroad. All materials were then sent to the Curtis Bay yard of the contractor where the final touches were added. The cofferdam sections were loaded with the contractors equipment (pumps, welder, etc.) on barges and towed across Baltimore harbour to Bear Creek

Erection of Cofferdam.

The construction procedures were as follows:—

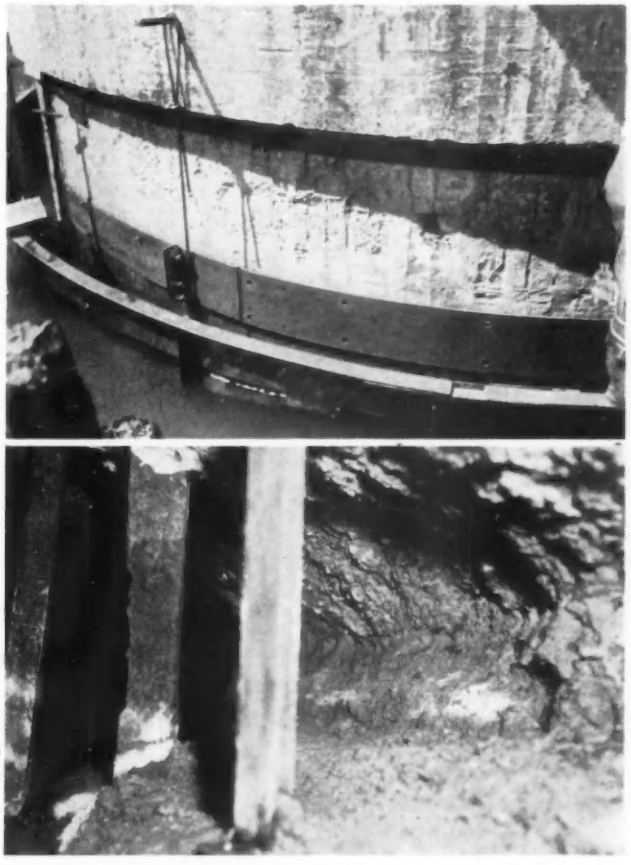
Upon arrival at the job site, the cofferdam was erected (partially submerged and in sections) so as to clear the bottom chord of the swing span. After assembly of the cofferdam all joints were checked for water tightness and the cofferdam was then lowered to its final position and clamped in place. Thereupon a pump was started and the water level in the cofferdam began to drop, indicating that the gasket seals were functioning. Before the cofferdam was entirely dewatered, braces and angle brackets were attached to the cofferdam and connected to the pier. They were designed to handle uplift of the cofferdam due to hydrostatic pressure and also the downward and outward forces of the weight of freshly poured concrete. The cofferdam was then completely dewatered; minor leaks occurred but were caulked immediately. A sump pump was used to remove any water that might infiltrate during repair.

A visual inspection was then made to determine the actual extent of deterioration. It was found that the disintegrated area completely encircled the pier and varied from 12-in. to 48-in. in depth, which was what the diver had indicated. Upstream and downstream points on the pier (points of zero stream velocity) had approximately 12-in. of deterioration. Points 90° away (points of maximum velocity) on either side had approximately 24-in. deterioration. The maximum deterioration of 48-in. occurred at a point midway between two of the nodal points (zero and maximum velocity points). This seeming lack of uniformity or definite overall deterioration pattern aroused speculation as to its cause; however, only a closer visual inspection could indicate a possible explanation. This inspection revealed that at the point of deepest deterioration (48-in.) there was a wide band (maximum 6-in. thick) of soft greyish clayey material, which undoubtedly was hydrated cement and other very fine materials. This band was wedge shaped tapering off about two-thirds across the pier. No doubt a laitance seam had developed in the original construction of the pier.

The above information led to the following assumptions concerning the cause of deterioration:—

(a) Deterioration due to alternate freezing and thawing, chemical action and possibly other factors resulted in approximately 12-in. of eroded concrete.

(b) Scouring at points of maximum velocity added about 12-in. to the deterioration, making it approximately 24-in. at these points.



Top. Cofferdam being dewatered after lowering into position.
Bottom. Inside the cofferdam after dewatering showing laitance seam and deterioration.

(c) The laitance seam created a point of additional weakness which resulted in the point of accelerated deterioration (approximately 48-in.).

It can be readily seen that the derivation of the above information was greatly facilitated by using the " Dri-por " approach to underwater repair.

Concrete Repair.

All power tools were pneumatically operated with compressed air piped from a 365 c.f.m. compressor on shore. All supplies and equipment were stored on two barges which were tied adjacent to the pier.

After the cofferdam had been anchored to the pier, labourers entered and removed all disintegrated concrete to a clean hard surface. Any surface which was not eroded, but against which new concrete had to bond, was cleaned or scaled. After this, dowels of reinforcing bars were placed in the areas of deepest deterioration while a second assembly of reinforcing was erected 6-in. inside the outside wall of the cofferdam. Only after this work had been completed and the cofferdam had been welded into a single continuous

Underwater Concrete Repair—(continued)

unit, was the form ready for concrete.

During the period when this preliminary work was in progress, work was halted only two hours one morning because of high tide. On several occasions the area near the top of repair was contaminated by floating scum. Because all work was done " in the dry " it was spotted immediately and removed. It is doubtful whether any other repair procedure could have detected this contamination so readily.

To handle the concrete pour, four vertical chutes or hoppers built into the swing span dropped the concrete to the bottom chord of the swing span. From each hopper, inclined portable chutes carried the concrete to any desired part of the cofferdam form. This procedure allowed water traffic to pass when the locomotive crane was on shore. On shore, the concrete was dumped from ready mix trucks into waiting one-yard concrete buckets which were placed on a flat car by the locomotive crane. The crane pulled the car to the pier and unloaded the buckets directly into the vertical hoppers. Once pouring had started, the contractor and the ready-mix suppliers, kept the concrete coming uniformly; the only delays being due to train schedules. The concrete consisted of a 7 : 2 bag mix including Pozzolith and sufficient Darex A.E.A. to entrain 4—6% air. A low slump was specified to increase the structural strength of the concrete.

After the concrete had cured for seven days, the supporting cables and brackets were removed and chipping of the deteriorated concrete on the upper section of the pier began. " Gunite " repair of this area completed restoration of the pier. The contractors for this work were The Masonry Resurfacing and Construction Co., Inc., of Baltimore, for whom the writer of this article supervised the engineering and construction work described above.

Shipping and the State

Address by President of the Institute of Marine Engineers

The development of the partnership between the shipping industry and the State to their mutual advantage was the theme of the presidential address by Sir Gilmour Jenkins, K.C.B., K.B.E., M.C., to the Institute of Marine Engineers on September 22 last. Sir Gilmour, who is Permanent Secretary to the Ministry of Transport, is also European Chairman of the Planning Board for Ocean Shipping under the North Atlantic Treaty Organisation and has represented the Government at maritime sessions of the International Labour Organisation.

After brief references to the relationship between shipping and the State from very early times, Sir Gilmour spoke of the widening of the world horizons at the close of the Middle Ages and the opening up of vast new Colonial territories. Great Britain became in the process a world power, the main provider of the world's ships and seamen and the carrier of the whole world's goods. The increased tempo of world trade in the great era of expansion in Early Victorian times allied to the discovery of steam power resulted in a rush by shipowners to take advantage of the great technical advances without adequate considerations for safety. Information about inadequacies and abuses began to reach Parliament with the result that new legislation had to be passed with increasing frequency. Thus it was a little more than a hundred years ago that the beginning of the great change in relationship between shipping and the State began. Henceforward active intervention in the industry by the government of the day became established custom A succession of Acts were passed to consolidate or centralise existing legislation. Much was accomplished by the support of progressive shipowners although at that time there was no single association to speak for the industry as a whole.

Royal Commissions and Departmental Committees were appointed from time to time and their reports formed the basis for new Acts of Parliament. Nevertheless, the impetus towards improvement came from skilful technicians and enterprising shipowners. Samuel Plimsoll had to fight an individual campaign in the 1870's for the introduction of the " Plimsoll Mark." The growing influence of the professional officers and surveyors of the Board of Trade and that of the classification societies also played an important part.

A movement towards greater cohesion throughout the industry began by the formation of such organisations as the Chamber of Shipping of the United Kingdom in 1878 to be followed by others as the quickening pace and complexity of trade and industrial conditions called for closer co-operation between mutually dependant interests. Nevertheless the period up to the First World War found the industry still lacking in cohesion. The Merchant Shipping Act of 1894 was primarily a consolidating Act and marked no important legislative advance. The Act of 1906 improved in a number of ways the conditions attached to employment in merchant ships and empowered the Board of Trade to establish Advisory Committees which were representative of all sections and interests. The first meeting was held in 1907 with Mr. Lloyd George (then President of the Board of Trade) in the chair. A committee continued to advise right up to 1939 and its expert opinion and knowledge enabled the British Government to take the lead towards establishing standards of safety.

An example of the close co-operation which exists between the Industry and the State, said Sir Gilmour, was the Third International Conference on Safety of Life at Sea which was summoned by the British Government in 1948. As soon as the conference was envisaged the British team, which included all sides of the Industry and the Ministry of Transport representatives, had detailed discussions with everyone concerned to decide what proposals should be placed before the conference. As a result the British delegation was able to put forward a full and constructive set of proposals which had the support of the whole industry. No other delegation was so well prepared or so sure of its ground and as a result the British proposals formed the basis of the 1948 Convention afterwards ratified by the principal maritime countries.

During the past 100 years the relationship between shipping and the State has progressed from regulation imposed from above, through co-operation by means of formal machinery to the present stage of continuous and friendly collaboration by day to day contact at all levels. " I have not the slightest doubt," said Sir Gilmour, " that the progress we have made together in ever-growing co-operation will be even more rapid in the future so long as the same spirit of honest endeavour and goodwill in the best interests of the Industry are maintained. . . ."

Port of Aberdeen

Opening of New Bridges at Victoria Docks

On Wednesday, 30th September, 1953, at 11 a.m., Her Majesty the Queen Mother officially opened the new bridges at the entrance to the Victoria Dock, Aberdeen. The opening ceremony marked a further stage in the Aberdeen Harbour Commissioners' long-term plans for the development of the port. To date, nearly £1,000,000 has been spent on various improvement schemes.

In spite of the production difficulties at present confronting the ports of the United Kingdom, Aberdeen Harbour Commissioners are alive to the need for meeting the challenge of competition, and the requirements for a rapid turn-round of shipping. This is shown by the post-war engineering programme which has already been carried out. The work so far completed comprises a series of major maintenance jobs, including new dock gates and a floating caisson, quay reconstructions, replacement of obsolete plant and the purchase of new cargo cranes. A short while ago a new deep water berth was completed at Matthews' Quay South with new quay construction to accommodate road and rail tracks, two 3-ton portal cranes and a new two-storey R.C. goods shed. Road access leading to this new berth was limited by lack of modern bridges on one of the routes, the existing bridges having been disused for some time past. Happily, this difficulty is now a thing of the past.

The contract for the new bridges was given to Head Wrightson and Company Ltd. of Thornaby-on-Tees, who have had a wide experience in the design and fabrication of the heavier type aluminium alloy structures.

We hope to give technical details of the construction of the bridges in a subsequent issue of this Journal.

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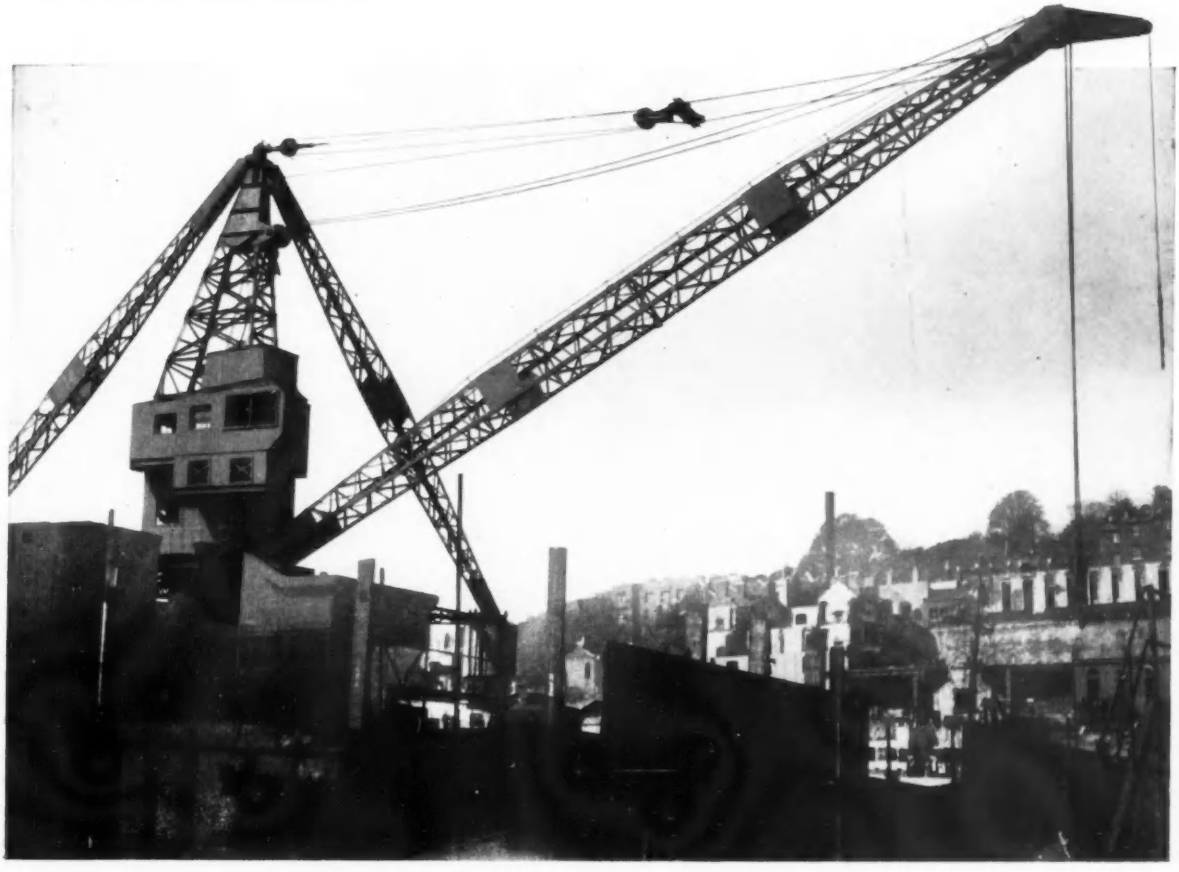
OVERHEAD CRANES
PEDESTAL CRANES



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The illustration shows a 35-ton Butters electric derrick crane installed in the Bristol shipyard of Messrs. Chas. Hill.

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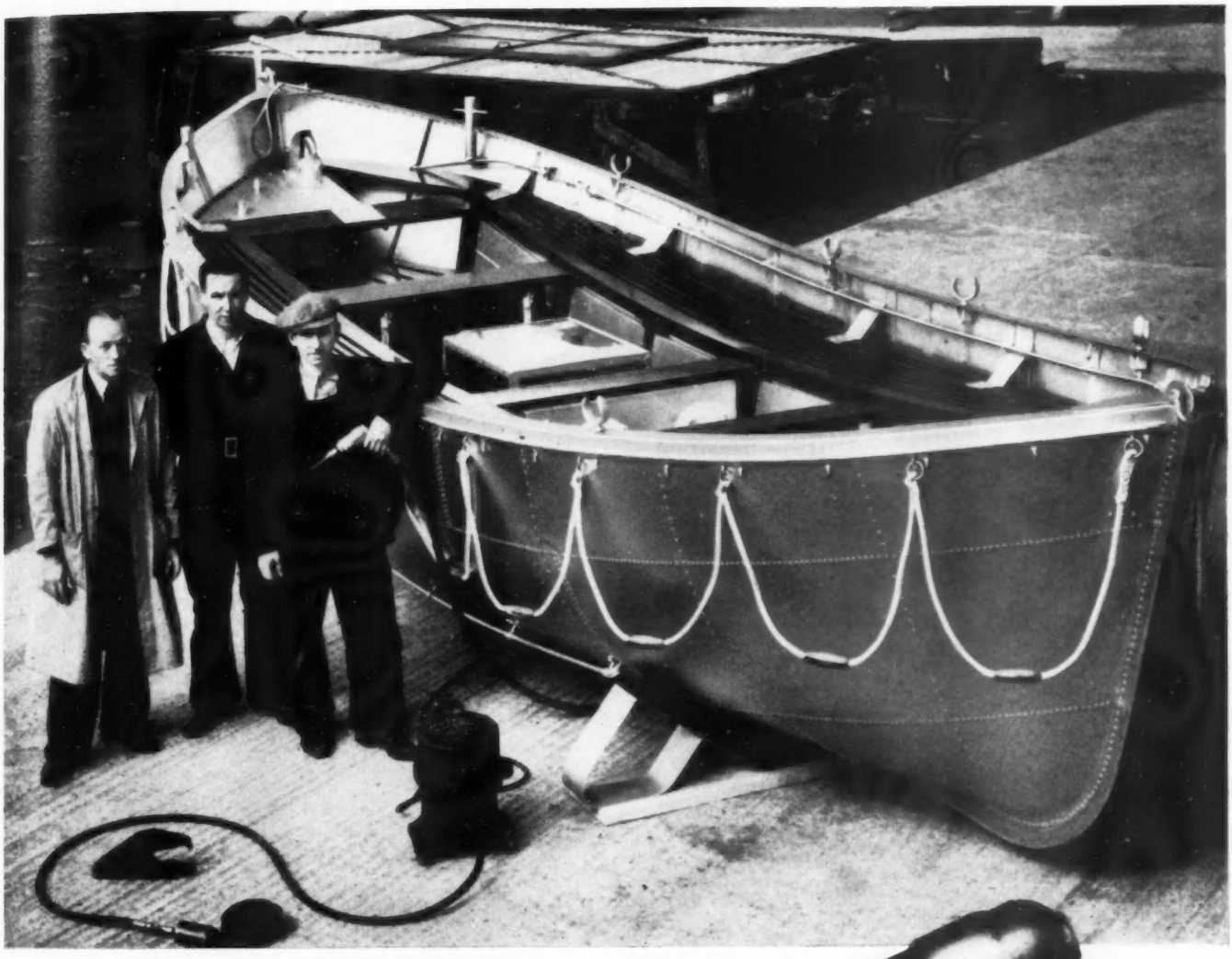

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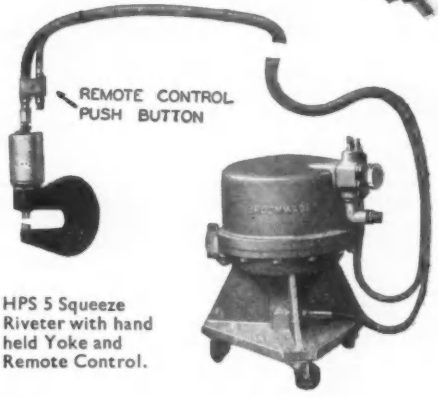

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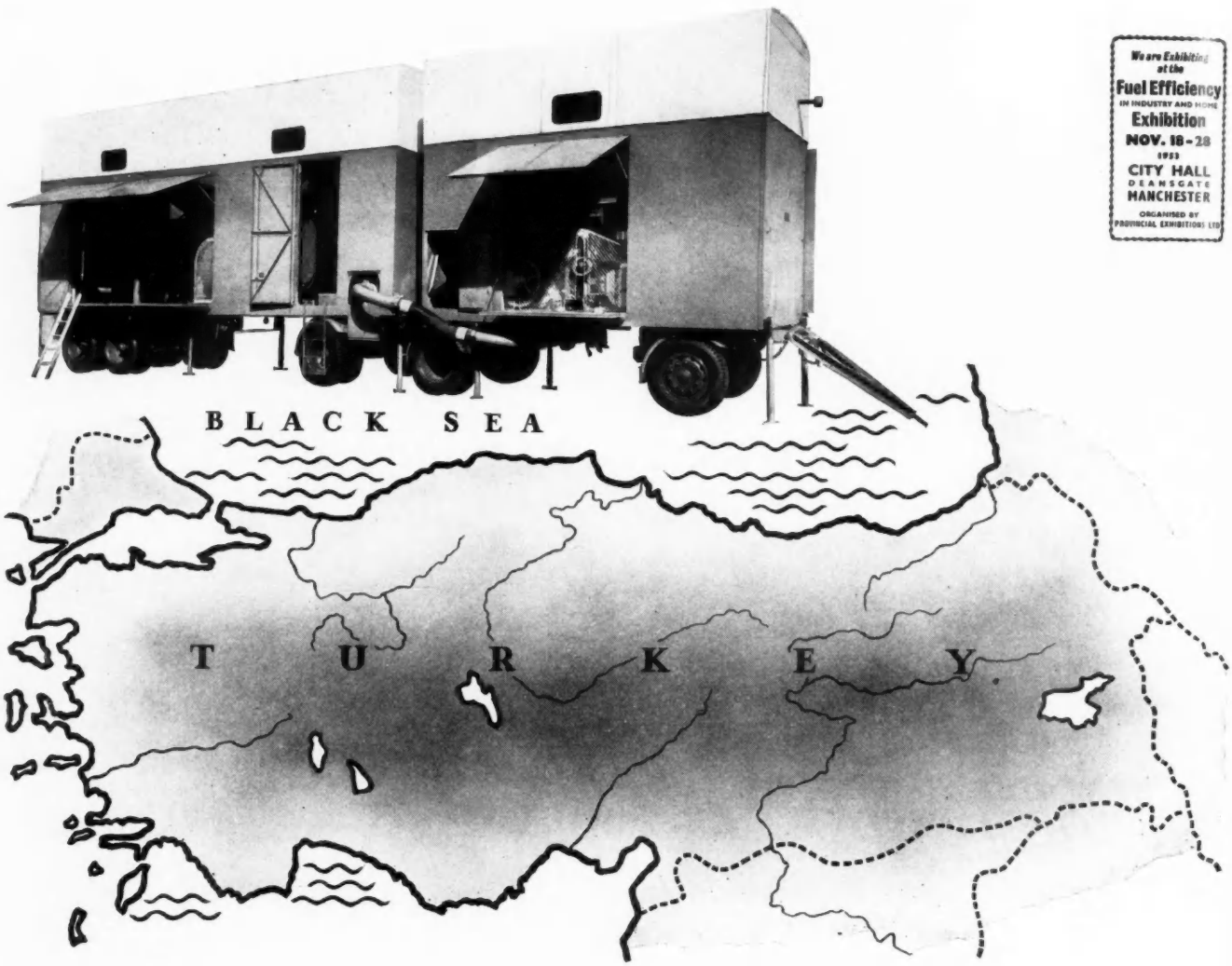

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Mechanical Handling of Awkward Cargoes

New Types of Mobile Equipment

(Specially Contributed)

Most of the more important Dock and Harbour Authorities throughout the world, together with the leading stevedoring concerns, have closely followed, and in some instances have anticipated, industry in the installation of mechanical handling equipment for the expeditious handling of cargoes during loading and unloading operations and in the warehouses.

Unlike most other industries, however, port operators in general, are usually faced with a peculiar problem in this respect. In the majority of industrial plants regularly producing and handling one or more standard products, it is usually possible to provide mechanical handling equipment either static or mobile which by experience has been found to be best suited to the particular handling problems which arise in the course of the production and storage processes.

Dock and Harbour Authorities and port operators, on the other hand, must always be prepared to handle a wide variety of cargoes of which there is rarely any regularity and consistency; in consequence the modern port must frequently have available at any given time a far greater variety of equipment than is customary in the average industrial plant; moreover, since in the main, loading and discharging of cargoes takes place at some distance from the warehouse, the railway siding, or the loading bays for road transport, it is usually essential for most, if not all, mechanical handling equipment employed to be both mobile and versatile.

The Fork-Lift Truck.

It is fair to say that in this category the now ubiquitous fork lift truck is probably the most satisfactory all-purpose mechanical handling unit for cargoes comprising cube loads such as cases, crates, etc., or bags and bales, and that except as regards very heavy loads, the fork lift truck is gradually proving more popular and versatile than the mobile crane.

This popularity is likely to increase as the unit/pallet load system of materials handling and transport, which is rapidly gaining universal favour in industry, is applied to a greater extent to general cargoes for shipment, as is already the case in the United States of America and Canada.

Both the fork lift truck and the mobile crane were really designed for the handling of cube loads, and in so far as this type of cargo is concerned, no particular difficulty presents itself. The handling and transport of lengthy commodities prior to loading, and after discharging, however, frequently presents an exceptional problem to port operators and because of their bulky nature it is usually essential to remove them from the quay as expeditiously as possible. Timber, steel sections, pipes, tubes, bars, railway track, telegraph poles, and similar long loads, come within this category. Because of their unwieldy nature and size, these goods do not readily lend themselves to the more conventional means of manoeuvring and transport by dock truck, fork lift truck, or even mobile crane, as is the case with cube loads.

Timber, in particular, is especially difficult to handle by normal means, since it is usually shipped or discharged " unsorted "; consequently, whilst individual lengths cannot obviously be handled individually, collectively they frequently present an "unbalanced" and loose load for the usual methods of transport which cannot economically be firmly parcelled because of the necessity of ultimate re-sorting.

The other typical lengthy loads referred to, whilst perhaps more capable of being contained in units, nevertheless are difficult to handle because when transported by mobile crane they present a " swinging load," which even if it does not get out of balance may nevertheless cause accidents and in any event involves no small amount of time in the securing and releasing of the load when picking up and setting down. Similarly, such lengthy goods do not provide a suitable load for fork lift trucks because of the necessity of conveyance transversely to the truck, thus presenting the same objection as in the case of mobile cranes.

The Straddle Carrier.

Because of the vast quantities of timber handled in North America, in the forests, in the lumber yards, at railway depots, and at the ports, it is not surprising that in the United States, as is so frequently the case with mechanical handling equipment, has evolved a machine now commonly known as the Straddle Carrier, which has done much to solve the problem of the expeditious and safe handling of lengthy loads.

As its name implies, the Straddle Carrier, unlike the mobile crane or fork lift truck which carries the load transversely in front, or the dock truck which carries it on top, " straddles " the load, which is thus carried longitudinally, and below the machine.

The first Straddle Carrier is said to have been invented in the United States some 35 years ago, since when several American manufacturers have entered this field.

Fundamentally, the design and principle of operation is the same with each make, and consists of a heavy steel frame carried by four members on four wheels. The power unit, diesel or petrol, and the transmission, are contained on the superstructure from which the machine is operated, and the loads raised or lowered in the space between the four wheels and below the superstructure mechanically, by means of steel angles attached at either end to vertical steel tubes.

The lifting and carrying capacity of the American Straddle Carrier varies from 10,000 lbs. to as much as 45,000 lbs., from which it will be noted that the capacities exceed those of the average fork lift truck, and even of the majority of mobile cranes.

In lifting and carrying lengthy loads at the docks the usual procedure is for the cargo to be discharged by ships' tackle or dock cranes in parcels of a weight and in dimensions as to height and width suitable to the type and capacity of Straddle Carrier for the purpose.

Most American manufacturers provide not only machines with varying load carrying capacities, but also with a wide variety of frame dimensions to accommodate a number of " package " sizes.

Before the " parcel " reaches the quayside, a " bolster " or dunnage is laid down to provide a base under which the hooks of the Straddle Carrier can obtain a purchase, and on this " bolster " or dunnage is dropped the load, usually by ship's derricks or dockside crane.

The Straddle Carrier raises the load a few inches from the ground by the simple process of approaching it longitudinally, straddling it, and lifting the load hooks, whereupon the load is carried away and deposited at the sorting depot or elsewhere. No binding or securing of the load is, of course, necessary, since it is held firmly, partly by gravity, and partly by the frame of the carrier in which it is enclosed. Hydraulically damped coil spring shock absorbers, and large diameter pneumatic tyres assist in providing rigidity during transportation.

Speedy Handling of Timber.

A further important feature of the Straddle Carrier is that whereas the operators of overhead gantries—in common use where large quantities of timber of consistently handled—are confined to the area in which they are erected, and fork lift trucks and even mobile cranes are limited in the distances which they can economically cover, and even so, at slow speeds, the Straddle Carrier is constructed to operate on the highway in the same manner as a commercial vehicle and at equal speed. It thus follows that in those cases where lengthy loads have to be transported after discharge for any considerable distance, the use of the Straddle Carrier obviates the time entailed in the transfer from gantry, fork lift truck, or mobile crane to road vehicle, and moreover economically combines, in effect, the attributes of both methods of transport.

A number of Straddle Carriers are now in use in United Kingdom ports, notably London, Manchester, Liverpool, Hull, Bristol and Glasgow, where considerable quantities of timber are regularly handled.

For example, the Port of Bristol Authority, which has justly gained a high reputation for efficiency and for the modernity of its methods in the mechanical handling of both bulk and general cargoes, has operated straddle carriers at Avonmouth Docks for over four and a half years. Initially, as no suitable British machine was then on the market, the Authority purchased an American Straddle Carrier. This machine has a minimum load capacity of about 6½ tons the extreme dimensions of the load aperture being

Mechanical Handling of Awkward Cargoes—continued

49-in. in height and 52 inches in width. The machine is driven by a 72 h.p. petrol engine, and is fitted with four wheel hydraulic brakes.

Since being commissioned, this Carrier has rendered continual service throughout successive timber seasons and when it is realised that last year's timber import into the Port of Bristol totalled some 224,000 tons, the heavy use made of the machine may be gauged. Throughout it has been in service at Avonmouth Docks, where it was formerly necessary to transfer timber for piling from the ship to the timber yards by internal user railway waggons. The distance between the timber discharging berths and the timber yard is about half a mile by road, and it has been found by experience that the Straddle Carrier is generally capable of keeping pace with one vessel, and sometimes two vessels, discharging timber for piling. The timber, on being landed to the quay, is built up into sets on bolsters and by maintaining a shuttle service between the quay and the timber yard, the carrier is able to keep the quay clear of congestion. On the relatively few occasions that the capacity of the Straddle Carrier has been overtaken, the machine has obviated congestion by transferring the sets of timber to a point clear of the discharging berth, and has later picked up the sets at that intermediate point, and has conveyed them to the piling ground.

The Straddle Carrier has transferred as much as 363 tons of timber during a normal working day, during which it has made as many of 42 trips from the quay to the timber yard, and back.

The machine has also been extensively used in connection with the substantial trade in heavy logs, mostly from West Africa, passing through Avonmouth Docks. A log weighing up to six or seven tons is quickly transferred from the quay to the stacking ground, or if the log has to be measured before being despatched by rail, to the rear of the quay for measuring.

Here again, the paramount function of the Straddle Carrier is to keep the quay clear from congestion.

Recently this Straddle Carrier was given an unusual consignment. One of the oil companies established at Avonmouth Dock was receiving a rail consignment of steel pipes 30-ft. long and 6-in. diameter, for a new pipeline. The pipes were off-loaded from the special railway waggons on to bolsters by mobile crane, and the Straddle Carrier then picked up each pipe in turn and laid the pipes end to end alongside a roadway over a distance of threequarters of a mile. The line of pipes commenced about half a mile away from the railhead, and the carrier completed within six hours an operation which would normally have taken several days; another example of the versatility of this type of equipment.

Economical Running Costs.

Whilst it is difficult to assess with any degree of exactitude the economies achieved by the Straddle Carrier at Avonmouth, a costing made by the Port Authority over a recent period — which incidentally was one in which maintenance expenses had been abnormally high, shows that a total cost of 1s. 2½d. per ton for transferring sawn timber from the quay to the timber yard compares with the corresponding figure of 1s. 5d. per ton for conveyance by internal user railway waggon. It should be borne in mind, of course, that the Straddle Carrier effects an economy in labour costs at the timber yard by virtue of its ability to set down the timber at the point where the timber gangs are working, since transferring to the timber yard by rail often entails a long carry to the pile. Furthermore, the value of the machine in avoiding quayside congestion, although it may not be readily capable of assessment, is a most important factor.

The foregoing examples, whilst relating to the Port of Bristol, are really typical of what is transpiring in other ports, where Straddle Carriers are already in use.

Until about 18 months ago Straddle Carriers were produced exclusively in the U.S.A., but nevertheless, despite dollar restrictions, a number have been imported into the United Kingdom under special licence, because of the essential nature of the services they perform, and the fact that there was no alternative equipment of British origin which would provide a satisfactory substitute.

However, as in the case of practically every type of mechanical handling equipment which originated in the U.S.A., it was not long before the challenge to the American Straddle Carrier was

Straddle Carrier handling timber at the Port of King's Lynn.

taken up by a British concern, which determined to meet American competition in this type of machine. After some two years of experimentation, the first British Straddle Carrier was evolved, and is now in production for the home and overseas markets.

This machine embodies the best attributes of the principal American Straddle Carriers, but includes improvements and characteristics which make it an outstanding example of British engineering in this particular field.

It is not the purpose of this article to provide detailed technical information, but since this machine is the only one of its kind made in the Sterling Area, a brief summary may not be out of place.

Description of British Machine.

The British Straddle Carrier has a maximum lifting and carrying capacity of over 18,000 lbs., and is produced with eight different dimensions of load aperture calculated to meet all normal requirements at home and overseas. The minimum aperture measures 47-in. x 54-in. high, and the maximum aperture measures 59-in. wide by 54-in. high. The machine has an inside turning radius of only 9-ft., thus providing extensive manœuvrability, and can be driven on the highway at a speed of 20 m.p.h. The power unit is a well-known make of diesel engine of 65 b.h.p. at 2,000 r.p.m., and the total weight of the machine is 4½ tons.

The load hooks are hoisted and lowered mechanically by a single lever, whilst the machine is in motion, if necessary, thus ensuring a speedy turn-round—the operation taking less than five seconds. Independently, working hand, and foot, brakes are fitted, the latter being hydraulic, and the hand brake manual. The design and construction of the frame and superstructure ensures maximum visibility to the driver under all conditions.

Although primarily designed, as are all Straddle Carriers, for rapidly picking up and transporting over distances, lengthy loads up to 40-ft. in length, and thus unsuitable for any other type of mobile handling equipment, this machine can be provided with special bolsters or pallets capable of being rapidly affixed to the base of the frame, which enables it to pick up and transport with equal facility more conventional loads such as long cases, and crates, containers, bales, sacks, drums, barrels, bricks, etc.

Whilst unlike the Fork Lift Truck, the Straddle Carrier is unable to stack or unstack the goods it carries, many users find it convenient and economical to use Fork Lift Trucks of comparable capacity, in conjunction with Straddle Carriers for this purpose, the two machines in combination providing a most efficient transportation and stacking system, especially where lengthy loads are the main problem.

In general the British Straddle Carrier can be said to constitute an outstanding addition to the continually increasing range of mechanical handling equipment produced in the United Kingdom.

Mechanical Handling of Awkward Cargoes—continued

and a distinct challenge to the monopoly previously held by the U.S.A.

The Side Elevating Carrier.

The Straddle Carrier has now been followed by an entirely new type of Fork Lift Carrier which possesses the great advantage of picking up lengthy loads, carrying them over any distances on the floor of the vehicle, and then either replacing the load automatically on the ground, or stacking it, as in the case of the conventional fork lift truck, to any desired height up to 12-ft. or more.

This new type of machine comprises, in brief, a four-wheeled platform truck or road vehicle, powered by either a diesel engine, or electric battery operated. Amidships is located a mast assembly with forks, almost identical with the equipment provided on an orthodox Fork Lift Truck. The mast assembly is, however, capable of being hydraulically extruded from, and retracted into, the vehicle, and at right angles to it. In this way a load can be picked up from ground level, or taken down from a stack alongside the vehicle, until the load reaches a point level with the floor of the vehicle, whereupon the mast assembly is retracted, and the load placed longitudinally on the floor. On discharging, the reverse operation of course takes place, the load being either unloaded to ground level or stacked at will. In short, such a unit comprises nearly all the advantages of a fork lift truck and road vehicle in one, and is particularly suitable for handling and stacking lengthy loads since, unlike the conventional Fork Lift Truck, it is possible to carry such loads longitudinally instead of transversely; moreover, being constructed for road work it is capable of covering any distance on the highway.

Since the load is handled at the side of the vehicle instead of at the front, as is the case with normal fork lift trucks, it follows that the unit can operate satisfactorily in very narrow gangways or aisles, whereas the conventional fork lift truck must always have sufficient space to " turn into " the stack which it is intended to load or unload. Crane attachments, booms, squeeze clamps, and other special handling devices which are now provided for use with orthodox fork lift trucks are also available.

These Side Elevating Fork Lift Carriers at present have a lifting capacity varying from 2,000 lbs. to 10,000 lbs.

In the handling of goods between two plants or warehouses located at a considerable distance apart, it frequently happens that Fork Lift Trucks are used for internal handling at each of the plants or warehouses, and that the intervening distance is covered by road vehicles on to or off which the Fork Lift Truck loads or discharges at the doors of the plant or warehouse. The Side-Elevating Fork Lift Carrier, however, is capable of combining all these functions; consequently, although these units, because of their special construction are more expensive than Fork Lift Trucks of similar capacity, it is apparent that in many instances they can replace the first cost of two Fork Lift Trucks and a road vehicle.

Side elevating Fork-lift Carrier—2-ton capacity.

At present Side-Elevating Fork Lift Carriers are only produced in Germany or the U.S.A., but a leading British concern has secured the manufacturing and distribution rights for the U.K. and British Commonwealth, consequently it is hoped that these unique machines will shortly be available to port operators and industry from sterling sources.

Both types of mechanical handling equipment briefly described above, by reason of their ability to rapidly transport lengthy and unwieldy loads from source to ship's side direct for loading, and for removing such loads after discharge direct to destination, without the necessity for double handling as regards either operation, should prove of material assistance in contributing to the quicker turn-round of vessels in port.

Port of Norrkoping

Canal Project and Plans for New Quays

According to the Journal " Sverige-Nytt," a 200-year-old project which is expected to increase considerably ocean-going as well as coastal shipping to and from Sweden's second largest port in the Baltic is to be taken in hand in the near future. This is the Lindo Canal, which will shorten the distance from Braviken Bay to the Port of Norrkoping by 3½ miles and at the same time provide space for extensive deep-water quays and sites for a large number of new industries in the port area.

The new canal, which will be one of the most extensive canal projects in Sweden during the century, will have a length of nearly two miles, a depth of 31-ft. and bottom width of 180-195 feet. At several places blasting will be necessary, and a channel two miles in length will have to be dredged through a shallow area before reaching deep water in Braviken Bay. The work is calculated to cost over Kr. 33 million (£2,276,000), which will be defrayed entirely by the city of Norrkoping.

The work will most likely commence this year with the construction of 980-ft. of quay with a depth of 30-ft., which will form an extension of the present South Harbour Pier. In direct connection with this quayage a new port basin, which will also constitute the terminal of the canal, will be built. This new port area will be equipped with cranes, railway tracks, etc., and all modern facilities for storing goods.

Other works, costing over Kr. 10 million (£690,000) at present being completed at the port are underground oil storage installations, and a number of new piers for the unloading and distribution of oil. In addition to the underground plant, which will be rented to private oil companies, the latter are building a number of surface tanks. When these are completed, the port will have facilities for storing over 150,000 cu. metres of oil, or seven times more than in 1947.

Further improvements include two new six-ton cranes and the modernisation of a number of the existing cranes. A large area of the old harbour yards are being paved with granite blocks and the railway track is being considerably extended. In recent years over 64,000 railway wagons have been loaded and unloaded in the port annually.

Though situated on a bay of the Baltic, the port is kept open for traffic throughout the year. During the last few years, the winters have been fairly mild, causing no serious problems to shipping. In the event of severe winters, however, the port's icebreaking vessel, " Icebreaker I " and the powerful tugs " Pampus " and " Cardon " — the latter delivered this year — keep the sailing channel open.

Although on an average activities in Swedish ports declined somewhat in recent years, trade at Norrkoping has continued to increase. During 1952 imports totalled 1,100,000 tons and exports about 350,000 tons. Among the imports, coal and oil and various raw materials predominate, while on the export side the principal commodities are timber, paper and cardboard, fertilisers and engineering products from the industries of Norrkoping and its hinterland.

Fire Protection at the Port of New York

Review of Future Plans*

At around 7.30 of the evening of September 28th, 1947, a guard making his rounds on the New York City docks of the Grace Line (15th Street on the North River) discovered flames creeping along the timbers of the substructure of Pier 57. Before another hour had passed, 80 pieces of land apparatus and six fireboats were on the scene attempting to control an eight-alarm fire that was gushing forth thick, acrid smoke and crackling fingers of flame from the creosoted-soaked piles and framing that supported the $3 million wharf.

Traffic was halted on the West Side Highway and 11th Avenue while firemen brought out pneumatic drills to try to force holes through the concrete lower deck in an effort to reach the flames. But by the time a few inches had been drilled the fire had edged its way further toward the bulkhead. Another hole further back was started, and again the fire would have reached beyond the drilling point. By midnight the entire superstructure — the wooden shed and grotesquely twisted steel supporting girders— collapsed in four sections with a deafening roar, and clouds of smoke and debris spiralled skyward. During the three days firemen fought to keep the fire under control, 140 were injured or overcome and, besides the pier itself, some 400 tons of cargo were destroyed.

A New Era

That was the end of the 40-year-old wharf that had been not only the scene of many sailings and dockings of passengers but had served as the loading point for hundreds of thousands of tons of precious Allied cargo during World Wars I and II. More important, perhaps, it was the beginning of New York City's rebuilding and remodelling programme for its 160 odd piers. For, while there had been other fires that had prompted much thought and discussion of modernizing and new building, the Pier 57 fire convinced the City, and especially the Department of Marine and Aviation, that the first step must be to " preserve what we have." Out of the lesson of Pier 57 came the 10-Year Plan for modernization and fire prevention, rehabilitation and new construction.

With the support of the then Commissioner of Marine and Aviation, a meeting was called of the fire chief and his deputies, insurance underwriters and fire prevention experts, rating men, engineers, and civic leaders. It was this meeting which initiated plans for the development of New York's modern piers and set up the committee under Commissioner Cavanagh to draft what has come to be known as the 10-Year Plan for the Rehabilitation and Development of the Waterfront of the Port of New York, adopted by the city authorities in May, 1949.

Under the Commissioner's administration in the Port of New York, rehabilitation, new construction and modernization along the waterfront have reached an unprecedented level; about half of the projected $58 million programme has been completed, including 99 per cent. of substructure fire prevention work; 100 per cent. of sprinklering on major piers and nearly half on all piers; and the new Pier 57 will take its place as one of the most modern and best equipped shipping terminals in the world.

What happened at Pier 57? What had happened, in fact, to all of the City's harbour facilities that such a major development programme should be necessary? Exactly the cause of the conflagration at the 15th Street North River dock has never been determined. One theory is that some live coals from a passing tugboat may have dropped into the water which at the time had a coating of oil on it, and that these coals drifted quickly toward the piles under Pier 57, smouldered and finally ignited the oil-soaked timbers.

Like all the City's piers, some of which date from 1870, construction was such as to permit a small punt, launched from a fireboat, to pass under the main deck and thus attempt to control a fire in the substructure. The trouble is that this works when the tide is low (assuming the fire is not out of hand), but not when high tide brings the water up to within a few feet of the lower planking. There was no way to reach flames at that point, as was proved too late on the night of September 28th when the firemen tried in vain to bore through the concrete deck.

Remains of Pier 57 after being destroyed by fire in September 1947.

War and Depression

But why were not plans made to remedy this situation long before? Undoubtedly, in part, because of inertia and lack of foresight. But it must also be remembered that, despite considerable new pier construction after World War I (13, for example on Staten Island, and several along both the East and North Rivers), many piers deteriorated from lack of use and exposure during the depression when shipping had fallen off and steamship companies, to whom the City rents its piers, had vacated. On top of this, there came along World War II: Time was of the essence; frequently turn-around time at the docks was only a few hours; sometimes 70 or more ships stood in the Narrows waiting for docking space; 60 per cent. of war cargo was from this country and a very large portion of this loaded at the Port of New York. There was no time for repairs, and installation of fire-prevention would have interfered dangerously with the loading of vital war material. So, for a period of almost 20 years much needed attention had not been given to the waterfront facilities of the largest port in the world.

The items of deterioration and inadequacy were outlined in a report of the Commissioner to the Mayor as follows:

1. Many piers were either too short, too narrow or too old.
2. Many slips (the water space between piers) were too narrow.
3. Most were not fireproofed, especially in their substructures.
4. Steel columns at the bulkhead end often obstructed truck movements.
5. Chutes and other handling equipment were in many instances obsolete.
6. Few had direct rail connections and required the use of lighters, floats, barges and trucks, resulting in more expensive operations than otherwise would have been necessary.

On the North River, for example, while 14 docks were in " excellent condition," 23 were reported fair but too small and three, dilapidated. One, Pier 57, had, of course, been destroyed at the time the survey was made.

The Port of New York

The North River is but one section of the Port of New York waterfront which consists of the Upper Bay, the Lower Bay, Arthur Kill and Kill von Kull, Newark Bay, Raritan Bay, and the connecting waterways we know as the East River, Long Island Sound, and the Harlem River connecting the East River at Hell Gate with the Hudson on the West, which in the vicinity of Manhattan is called the North River. This area is literally fingered with piers and ships, either loading or unloading.

*Abstract from an article which appeared in " The Spectator," June 1952. Reproduced by kind permission.

Fire Protection at the Port of New York—continued

The Port of New York traffic is not only five times greater than that of Philadelphia (its nearest competitor) in dollar volume—$8 billions in 1951—but is twice that port's volume in tonnage. New York City embraces three-fourths the Port's population and handles 70 per cent. of the Port's commerce of general tonnage (more on a dollar basis). The 675,000 persons employed in the trucking, importing and exporting, banking and marine insurance fields, and along the waterfront constitute one-tenth of the City's population. Payrolls and supplies for ships amount to a half-billion dollars a year. $100 millions of this is for shipping labour alone. It can be seen, then, what the Port means to New York's prosperity, to people's livelihood, and what would happen if the Port were allowed to deteriorate beyond repair. Pier 57 alone employed at least 1,000 people at operations peak at a payroll of $2 million annually.

So, along with the Port of New York Authority and the World Trade Corp., a state-chartered corporation sponsored by business and civic leaders, the Department of Marine and Aviation of the City of New York prepared plans for the Port's renovation and modernization. The Department's Plan was approved by the City fathers, and that is the plan under which the City is spending some $58 million or more (subject to cost changes over the 10-year period since 1949).

The 10-Year Pian

While the plan called for certain general specifications at certain estimated costs within certain specified periods of time, a number of changes have been made in construction specifications, time dead-lines and cost. This has been partly due to newer, more efficient ways of construction, partly to unexpected problems and inflated prices.

Another influencing factor is the prospect of getting tenants, for the City leases its piers, for the most part, to private interests. Reconstruction, therefore, is usually timed to start when a pier lease has been signed and a tenant's special requirements, if any, worked into the reconstruction blueprints.

But, let us take a look at the original draft of the 10-year plan, remembering that it has been revised for reasons just noted:

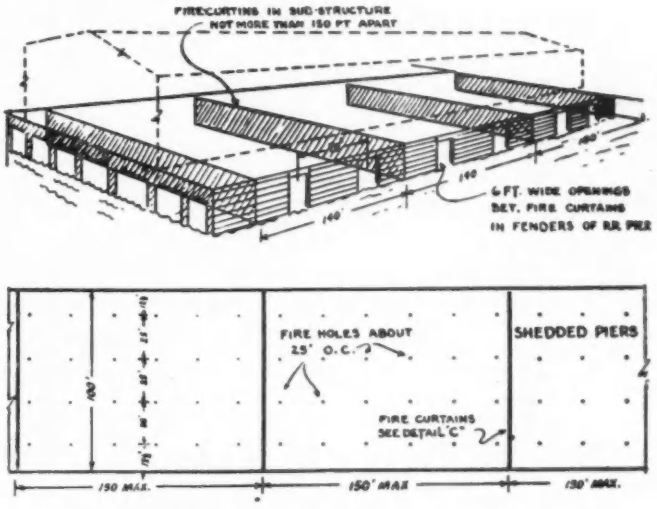
The 10-year plan is part of the City's Master Plan for over-all development of the waterfront. It is divided into four parts:

1. New Construction.
2. Rehabilitation.
3. Reconstruction and Installation of modern mechanical equipment.
4. Fire Protection.

Sections two and three of the Plan include adapting inshore fronts to more efficient truck movements to relieve street congestion; additional hoists, chutes, ramps, elevators, etc.; more and better storage space; repair, renewal of deteriorated parts; painting; wider door openings; building of longer and wider piers; installation of stronger pilings; steel framing of sheds; construction to take heavier loads; more passenger and truck ramps; replacement of corroded metals and defective girders; overhauling electrical facilities; installation of modern lighting, heating and plumbing, and the like.

Fire protection and prevention work includes automatic sprinklering; construction of concrete fire walls and of metal fire curtains; manual alarms and rate-of-rise automatic dry pipe sprinkler systems; fire holes; installation of adequate water supply and of standpipes.

Aerial view of piers on the North River.


FIRE CURTAINS IN SUB-STRUCTURE NOT MORE THAN 150 FT. APART
6 FT. WIDE OPENINGS BET. FIRE CURTAINS IN FENDERS OF RR PIER
FIRE HOLES ABOUT 25' O.C.
SHEDDED PIERS
FIRE CURTAINS SEE DETAIL 'C'
150' MAX.
150' MAX.
150' MAX.

Cross-sections showing fire holes and fire walls of typical pier.

Of course, much of the rehabilitation, modernization and new construction will, in themselves, make the piers more fire resistant. We are concerned here, however, with fire prevention and protection. Here is what the 10-year plan calls for in the way of fire protection:

For Unshedded Wooden Deck Piers:

1. Trenches about a foot wide across the pier every 100-ft. along the length of the pier, to be covered by solid timbers that may be lifted out when fire apparatus must be inserted to fight a fire. Wider piers to have additional trenches at more frequent intervals. (Trenches serve the same purpose as fire holes in shedded piers, but are substituted because protection from smoke is not needed on an open pier.)

For Unshedded Concrete Deck Piers:

1. A line of 6½-in. circular openings (fire holes) across the pier 10-ft. apart every 100-ft. along the length of the pier, to be protected by cast iron insulated covers. Wider piers to have more fire holes.

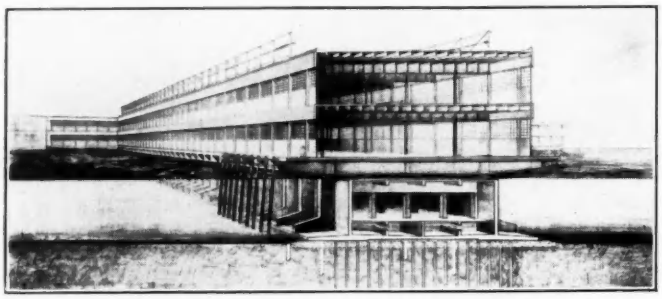
For Shedded Piers:

1. A line of 6½-in. fire holes at 25-ft. intervals transversely and longitudinally, with similar covers.
2. Fire stops of 6-in. reinforced concrete supported by 12-in. timbers in the substructure across the width of the pier not more than 150-ft. apart, to run from mean low water to the underside of the pier.
3. Six distributor nozzles for each pier, to be stored at locations designated by the fire department. Note: A special nozzle, called the Quayle Nozzle, has been devised which, when inserted in a fire hole in the main deck, shoots a swirling spray of water horizontally and up toward the underside of the deck, rather than down where it is not needed. (Capacity of Quayle Nozzle: 350 gallons per minute; covers 100 square feet.)
4. Bulkhead platforms between adjoining piers to be sealed off by a 6-in. concrete fire stop.
5. Special provisions are made for piers handling products with unusual hazard, such as sisal, hemp, flax, etc., and for railroad piers.

The Superstructure:

1. Automatic sprinklers with supervisory alarm systems.
2. Metal fire curtains hung from the roof separating each sprinkler valve unit. These prevent fire from blowing the length of the

Fire Protection at the Port of New York—continued



Model of new Pier 57 from the outshore side.

pier and concentrate the heat near the sprinkler system.

3. Fire resistant enclosures equipped with self-closing, fusible link covers or doors for all openings between floors.

4. Manual fire alarms connected to Fire Department headquarters at street end of pier.

5. Access to roof at both ends of piers.

6. Access doors on each side of both ends of pier sheds.

7. Fire walls to separate adjoining pier sheds, extending from main deck to three feet above shed roof, located along substructure fire stops. Openings in fire walls to be equipped with counterweighted, self-closing fire doors.

8. Standpipe systems with fire hose outlets properly spaced along pier. New installations to have electrically or pneumatically-controlled fire hose station break-glass alarm boxes.

9. Fire fighting water supply lines to be separate from ships' water supply lines.

10. Indicating signs for all fire protection equipment.

11. Large "No Smoking" signs at appropriate spots.

Many of these standards, of course, merely call for more modern apparatus or for more units. But the fire walls in the substructure and the fire holes and trenches as well as the fire curtains were new recommendations made after expert studies and influenced strongly by the experience of the Pier 57 fire and others. If the fire-fighters had been able at that dock to insert their hoses in the main deck through fire holes, and if fire walls had been below the deck to prevent the spread of flames, Pier 57 would be in existence today and would have needed only modernization and some rehabilitation. That this is so has been proven by experience with at least two fires on piers in which these remedies have since been installed.

Tenants' Expenditures

A factor in which the tenant is involved is the maintenance of the piers and of insurance on them. The tenants' lease contract requires him to maintain the premises in the condition in which he finds them at the beginning of the lease, and to complete such maintenance as may have been deferred during his occupancy should he vacate the premises. It also requires the tenant to maintain fire and extended coverage insurance to replacement value, as well as liability insurance. All piers are inspected periodically by the Department of Marine and Aviation to assure that adequate insurance is in force.

Of course, in addition to improvements on the City-owned piers, several millions are being spent on such privately-owned waterfront facilities as those of the Bush Terminal, New York Dock Co., and Beard's Erie Basin. These private companies are obliged to comply with Fire Department standards and have accordingly begun or completed installation of fire holes, fire walls, fire curtains and other fire prevention aids. About half of all New York Port docks are privately owned.

Building New Pier 57

Any account of the progress of the 10-Year Plan and its effect on fire protection and fire insurance costs must include the phenomenal engineering project involved in the construction of the new Pier 57, which is the outstanding example of a departure from the conventional standards for new construction and fire protection set up in the Plan.

The Pier 57 design has no piles except for a few wood fender piles (piles around outside edge of pier against which the ship is berthed) and a small number of steel-concrete piles under the bulkhead and anchoring the substructure. Old Pier 57 was supported by 4,000 wooden piles, which are cut off in the new design about 33-ft. below surface, the stumps being used to preserve the stability of the soil at the site.

Instead, Pier 57's substructure consists of two 27,000-ton reinforced concrete pontoons built 38 miles from 14th Street, North River and floated down the Hudson to their final destination. In addition, the bulkhead shed rests on a third such concrete pontoon built at the same site. The buoyancy of the pontoons themselves carry a large proportion of the dead weight of the pier. There are no fire holes and no fire walls—these are made unecessary by this new prototype.

By the desire of Grace Lines to increase the load capacity at minimum construction and maintenance expense, new Pier 57 will support cargo loads of 350 pounds per sq. ft. in the basement, 600 per sq. ft. on the main deck, 450 on the second deck and 100 on the roof. This vastly increased capacity (old pier capacity, 750 per sq. ft. total) would have required literally a forest of piling at tremendous driving expense and with a minimum resistance to sea borers and high maintenance cost.

Other advantages are: high fire resistance — storage space of 360,000 square feet in the basement (i.e., the two pontoons) and 80,000 square feet on the roof—berths 235-ft. wide on either side —separation of truck traffic from taxi, private car and other passenger traffic at the bulkhead (inshore end), with ramps for all kinds of traffic—auto ramps leading to the basement for discharge of baggage and passengers—conveyors to take baggage from basement to loading deck—elevators for passengers.

The former brick-making clay pit, the site selected for construction of the concrete pontoons at West Haverstraw, N.Y., needed to be pumped dry of 350 million gallons of water (a three-week job). The construction scheme also involved the erection of travelling cranes, a concrete batching plant, ready-mix trucks, steel and form fabrication yards, special jigs for reinforcing operations, and testing devices for concrete.

When the pontoons were ready to float down the river the water was re-admitted to the pit, the dike broken and the pontoons floated in a piloting and towing operation necessitating the utmost skill in handling. They were carefully spotted over their permanent location at 15th Street and sunk by admitting fresh water into them, being held in place by 30-in. diameter steel piles driven to the river bottom through openings in the side walls.

The cost of the entire operation is said to be around $10,500,000. Joint contractors on this project are Merritt-Chapman and Scott Corp. and Corbetta Construction Co., Inc. The consulting engineering company is Madigan-Hyland.

Since 1949, to January, 1952, the City and private tenants together spent something more than $26 millions under the 10-Year Plan. While much is still to be done, the 10-year plan is well on its way—and that in itself is an achievement.

International Meeting on Oil Pollution.

An international meeting of representatives of 10 nations will be held in London on October 27 to press for action against oil pollution of the sea. The meeting, which will be held at the Institution of Electrical Engineers, Savoy Place, London, has been convened to arouse public opinion on the subject. An official report made to the Minister of Transport during the summer stated that the only effective way to solve the problem was to prohibit ships from discharging waste oil into the sea. To achieve this, international agreement will be necessary.

The Minister of Transport, Mr. A. Lennox-Boyd, will open the conference, which will be presided over by Mr. James Callaghan, M.P. (Cardiff). Speakers will include: Lord Hurcomb; Sir Douglas Ritchie (Dock and Harbour Authorities' Association); Mr. D. F. Anderson (General Council of British Shipping); Mr. Mogens Black (Port of Copenhagen); M. Leon Lippens (Mayor of Knocke, Belgium); Mr. Banks Belt (Atlantic Waterfowl Council, New York); and Professor J. Berlioz (Natural History Museum, Paris). A number of local authorities are sending representatives.

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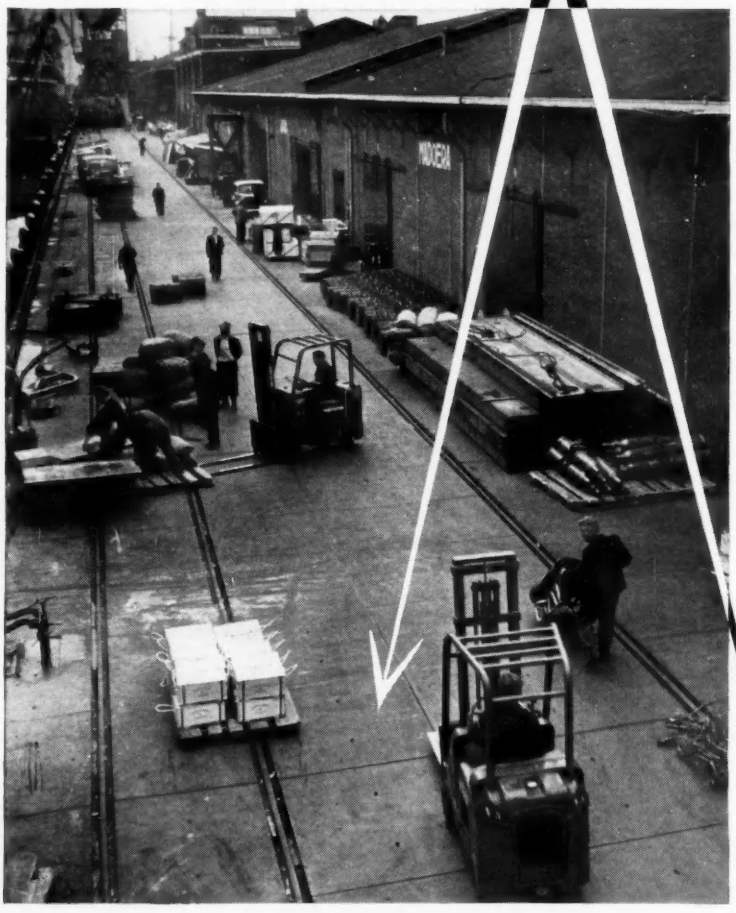

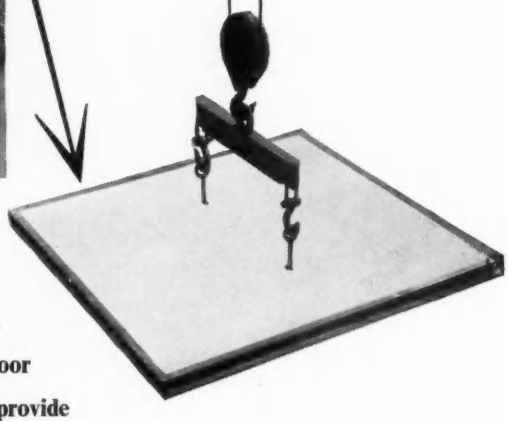

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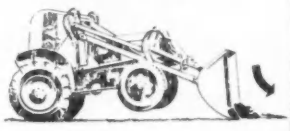

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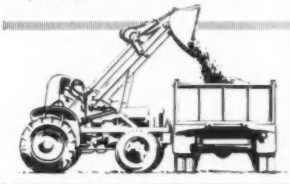

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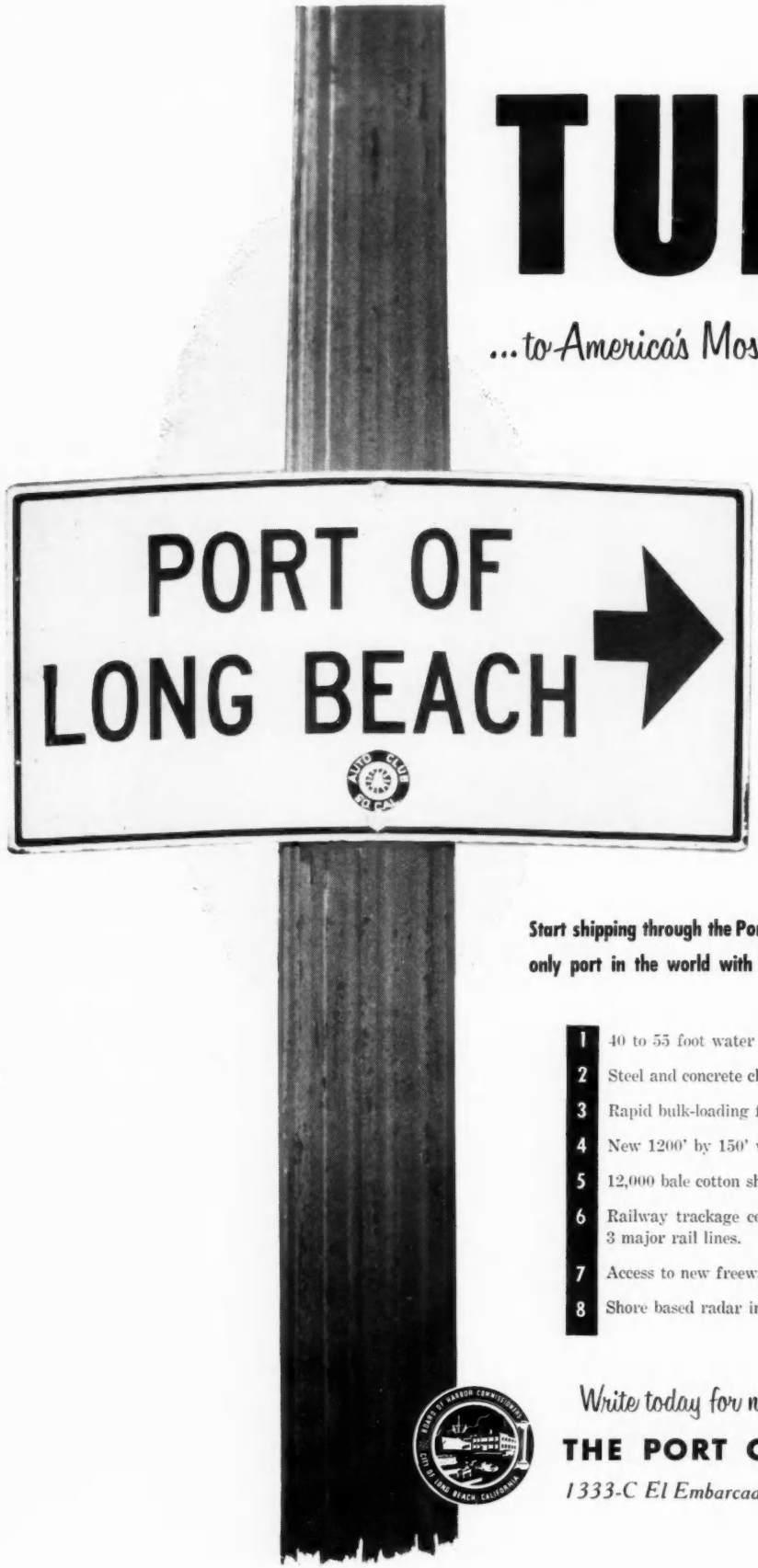

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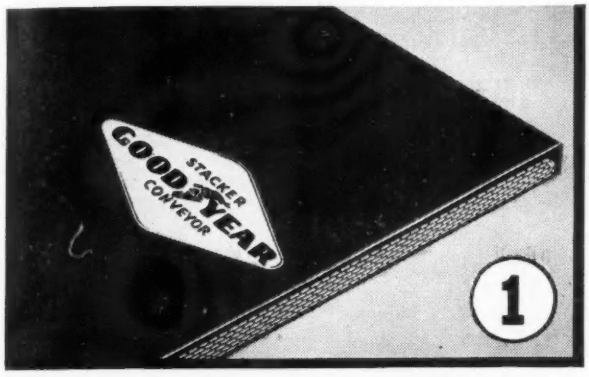

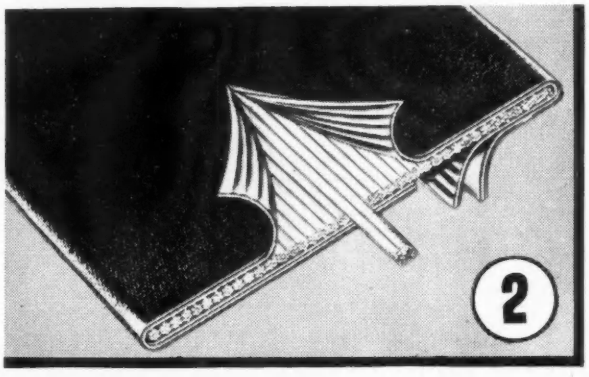

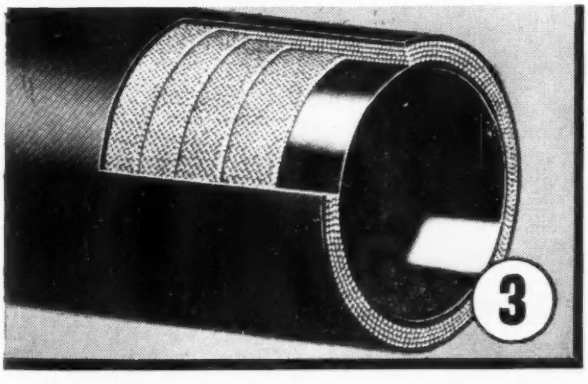

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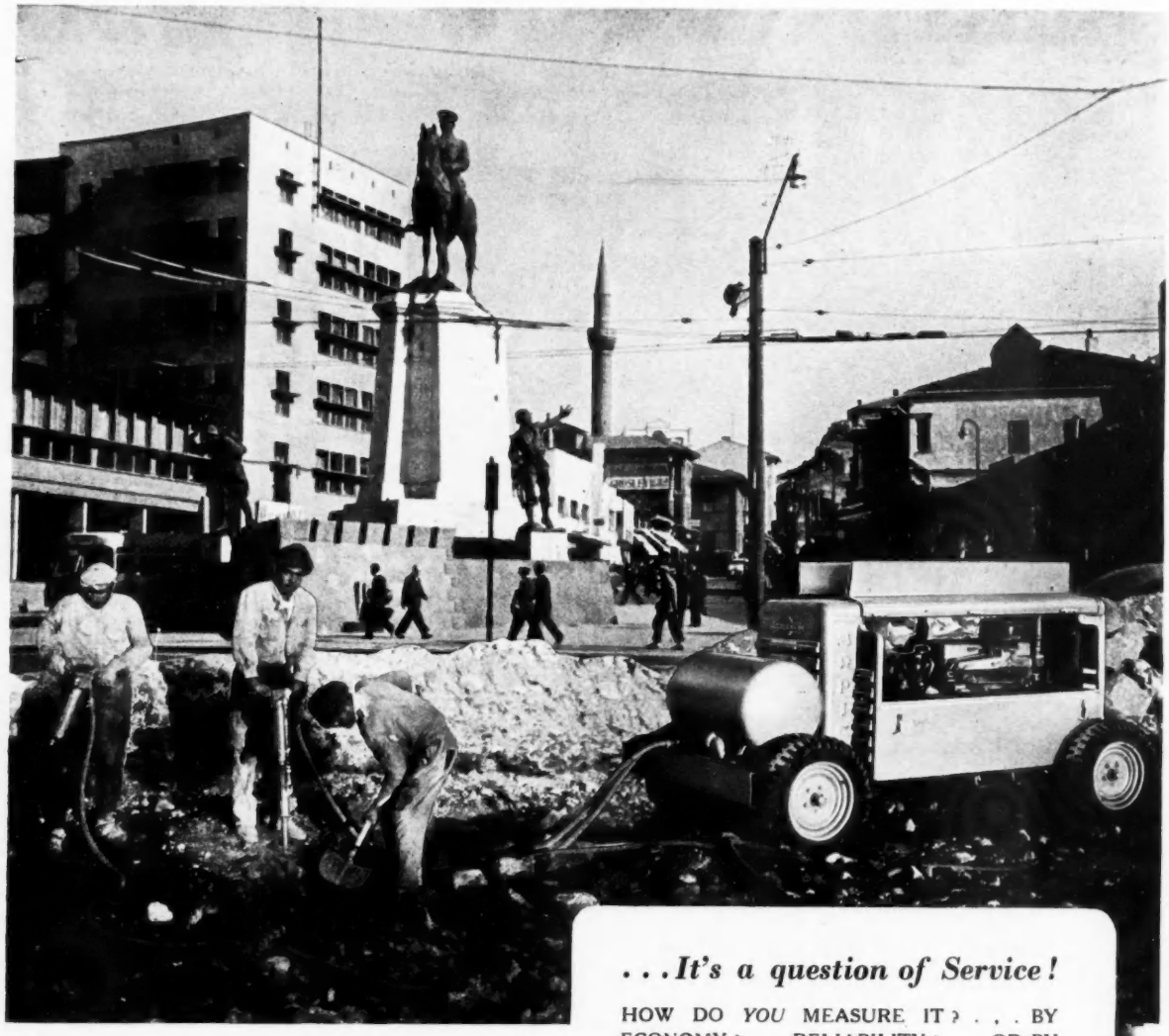

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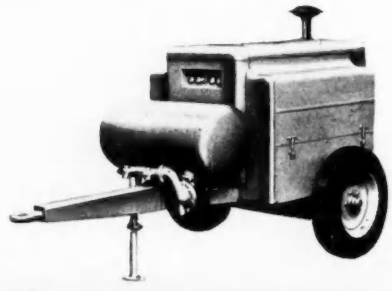

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Go-Downs and Transit Sheds

A Ctesiphon System of Construction

By J. H. de W. WALLER, D.S.O., O.B.E., M.E., M.Sc., M.I.C.E.

Introduction

THE purpose of this article is to describe with economy in technical detail the application of the true or catenary concrete arch, in corrugated form, to the general problem of providing unobstructed covered space on a scale commonly demanded of Port Authorities. Modern stacking methods; the capacity, operative radius and mobility of up-to-date lifting tackle; the universal urge for increased speed of handling, and new demands for storage space of all categories due to the spread of bulk purchasing, combine to emphasise the desirability of taking every possible step to provide for maximum freedom of movement through increased headroom and large span construction.

The virtual replacement of the travelling gantry by the mobile crane and the adoption of self-supporting roofs in arched form make it possible in many cases to completely eliminate those inveterate obstructors, the column and girder. Under exceptional conditions where lack of ground space make vertical walls desirable tied arches of single or multi-span may be used; it is suggested, however, that careful consideration should be given before departing from the free arch, in single or multi-span form, for such a course can only result in the sacrifice of at least some enclosed space, and the restriction of the choice and circulation of handling equipment.

Two Basic Principles.

The system described in the following paragraphs, known as the Ctesiphon (pronounced Tessifon) System, employs two basic principles and in their practical application introduces new methods of shuttering.

The True Arch.

The first principle is that of the true or catenary arch. Non-technical readers may be interested to know that these arches, as the name catenary implies, are formed to the curve of a hanging chain, reversed, and one of the oldest engineering principles lays it down that just as the chain achieves stability solely by virtue of tensile forces—little pulls between the individual links—so the arch constructed to such a curve derives its stability as the result of compressive forces alone. In practice the significance of this principle can scarcely be over-estimated because the main statical condition present in these arches, *compression*, is inherently agreeable to our cheapest and most durable, widely available and easily worked material—concrete—and the need for steel, allergic to corrosion and fire, is to all intents and purposes avoided. Concrete under tension is miserable and, at an early stage, cracks; under compression it feels really well, faces the elements with composure and virtually defies time.

Corrugation.

The second principle used is that of corrugation by which means requisite stiffness is imparted to the structure with extreme economy in shell thickness. If a thin shell is used, even though perfectly stable when at rest, it requires to be stiffened in order to enable it to resist the external influences that tend to make it depart from its original catenary form; such influences are loads, external or internal, applied intentionally or otherwise; wind; snow; vibration; temperature variation etc. In the Ctesiphon system the constructional methods used give the designer an exceptionally wide range of choice in the depth and width of the corrugations and in effect enable him to stiffen the structure to any extent desired. By virtue of this control the designer may, if he so desires, entirely eliminate the use of reinforcements so far as the stresses due to wind are concerned leaving him merely with the minor expense of providing steel to meet stresses arising from shrinkage of the concrete while maturing, temperature change and so forth.

One other result employing the catenary arch is that it gives what practically amounts to an unrestricted choice of span. In girder construction, and this applies to all forms of girder irrespective of the materials used, the weight and consequent cost of the structure per sq. ft. of floor covered bounds up as the span increases and thus severe economic restrictions on spaciousness are imposed. With the modern Ctesiphon Arches shell thickness need not exceed 3 to 4-in. even when spans run to 300-ft. and more, and in consequence the cost per unit of floor area rises very little as the spans increase, while the cost per cubic foot falls rapidly with increase in span.

There is another very simple way of contrasting the characteristics of arch and girder construction and it should be borne in mind that we are compelled to choose one or the other system when considering such simple structures as those under discussion. Apart from providing an impermeable envelope with appropriate qualities, our main problem in design is to meet the stresses imposed on the building by gravity. In the catenary arch, as mentioned above, gravity presses the particles together and thus induces stability: in the girder the action of gravity is to bend the member down, to disrupt and destroy it. Is it not acting in direct opposition to the natural law to use the girder when the arch is suitable?

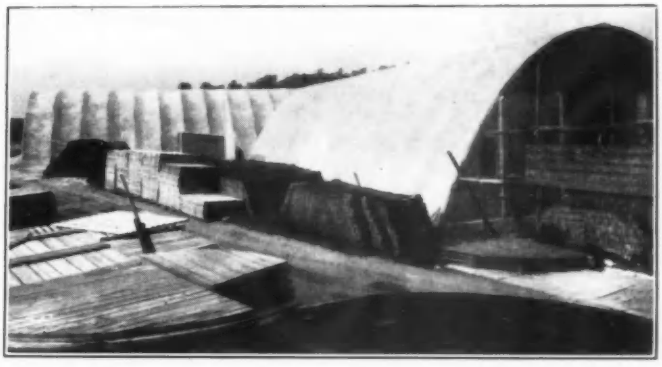


Fig. 1. Stores for Tentage. 40-ft. by 105-ft. for R.A.F. at Hermitage, Berks (by Scaffolding (G.B.) Ltd., Mitcham, Surrey).

What the Arch Offers:

Omitting small buildings under 40-ft. in span in the forms of structure so far constructed may be classified as follows:

Free Single Spans.

Two prototype stores were built for H.M. Air Ministry in 1943, 40-ft. in span and 105-ft. long (see Fig. 1). They contain no steel and are *only one inch thick*. Whereas no anxiety was felt by the writer, who was responsible for their design and construction, as to their stability, experience gained from numerous earlier examples of 20-ft. and 30-ft. span pointed to there being a necessity for definite precautions against minor imperfections developing owing to inevitable contraction and expansion (due to temperature change) and, in particular, to the contraction of the concrete while maturing. In this case as speed was imperative and as the sheds had to be camouflaged immediately they were built, it was decided to depend for impermeability upon a bituminous coating. In the result the experiment met with quite an unexpected degree of success. The contract price, without floors and ends but including professional fees and royalty (the Ctesiphon system is patented) was less than 5s. per sq. ft. of floor. This, it is understood, was less than that of the conventional 30-ft. corrugated iron shedding built on the site at the same time. The situation at the time of writing is that although the bitumen has long since perished both Ctesiphon buildings remain in full service and in first class shape. Their neighbours have been removed.

Go-Downs and Transit Sheds—continued

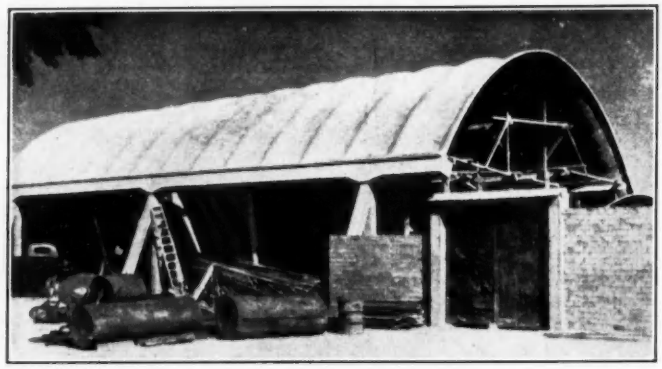


Fig. 2. Hangar for Trainer Planes. Open-sided, using A-frames (by Iberlar, S.A., Madrid).

In all, some 50 or 60 buildings were built in the war and considering the hectic conditions then prevailing and the fact that no steel whatever was used, it may be considered a matter for congratulation that in only two cases, both of which were built with a bare minimum of supervision, did any serious defects develop.

Since those early days a great deal of study has been devoted to this problem and exhaustive stress analyses for large spans have been made. In this connection it may be mentioned that standard methods of stress determination are applicable and there remain no known obstacles to the preparation of completely reliable designs even for spans up to 500-ft. in the clear. Engineers will also note, in some cases with pardonable relief, that the lengthy and mysterious calculations that characterise the design of contemporary " barrel vault " roofs are obviated.

Tied Arches.

When for any particular reason vertical sides are desired or, on account of site conditions are unavoidable, arches may be carried on walls or columns and lintels, the horizontal thrust being taken by ties.

In designing the ties it must be remembered that the arch is a comparatively rigid structure: the tie on the other hand is elastic and whatever the quality of steel, unless precautions are taken, will stretch when centring is removed and thus impose a bending moment at the crown. It may be reasonably argued that this is of slight importance but when spans become large the spread becomes considerable, increasing proportionately with the span. The obvious remedy is to pre-stress the tie before striking the supports. Any method of pre-stressing will serve and stressing should proceed until the arch lifts slightly. Thus no complications as to measuring the stress in the tie arise.

An obvious alternative to the tied arch is to employ buttresses (see Fig. 2).

Multi-Span Construction.

Where a range of sheds is required with limited head room the designer has complete freedom of choice.

End spans may spring from ground level or ties may be used. Examples are shown in Figs. 3 and 4. This form obviously offers an exceptional choice in warehouse construction for all purposes.

Domed Ends.

When domed ends (see Fig. 5) are permissible they show a marked economy over conventional vertical walling: not only is there a large saving in materials but, in contrast with walling, every cubic foot of material in the dome increases the floor area.

Side Access.

In many cases doors are required in the sides and they may be provided on any scale desirable. To transmit the thrust of the arch down to foundation level A-frames or wing walls, with lintels are employed by which means not only doors but completely open-sided buildings may be provided (see Fig. 2).

Glazing.

In many cases the best and cheapest form of glazing is the strip form shown in Figs. 3 and 6. These strips of glazing are particularly attractive in that they act as expansion/contraction joints and so serve a dual purpose. In addition they give an admirably even distribution of light, and area for area are supremely efficient.

If ¼-in. rough cast wired plate is used no glazing bars are required for strips up to 2-ft., in width, the glass being secured by copper tingles. In Fig. 3 the strips are 8-ft. wide and are glazed with curved corrugated perspex sheets fixed to teak grounds.

Alternatively to the above a varied assortment of patent glazing may be used.

Dormers and deadlights present no difficulty.

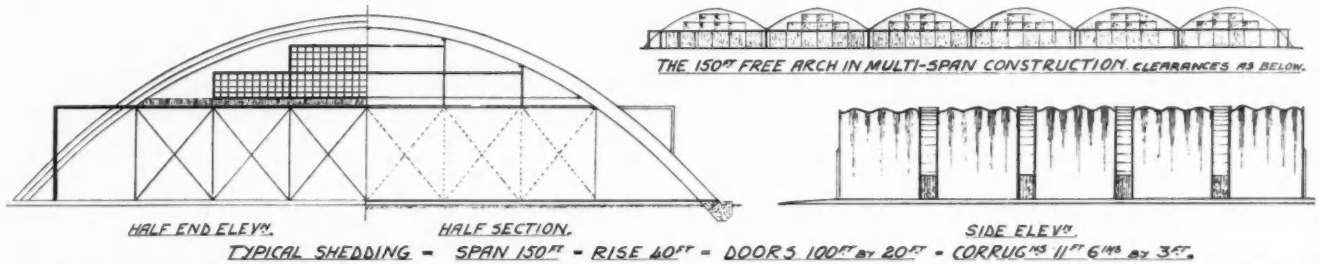

THE 150FT FREE ARCH IN MULTI-SPAN CONSTRUCTION. CLEARANCES AS BELOW.
HALF END ELEVN.
HALF SECTION.
SIDE ELEVN
TYPICAL SHEDDING - SPAN 150FT - RISE 40FT - DOORS 100FT BY 20FT - CORRUGNS 11FT 6INS BY 3FT.

Fig. 3. Multi-span Airport Shedding for N.A.T.O., Greece. Lintol height 20-ft. Door openings 100-ft. by 20-ft. (proposed by The Economical Buildings and Trading Co., Nicosia, Cyprus).

Some Considerations Effecting Design

Rise/Span Ratio.

The ratio of rise to span will generally be dictated by the purpose for which the building is required and it should be borne in mind that increase in headroom does not of necessity mean a serious increase in price as noted above: the shell thickness will be unaffected, so the extra for materials is not a big item. Extra height of scaffold may prove the principal consideration. If the ribs are prefabricated (see later) increased height may be obtained as in Fig. 2 and the cost may be considerable. If on the other hand Standard tubular, Rap-rig or similar adjustable falsework is used extra height is not a matter of great importance.

Fig. 4. Sisal Factory, floor area 90,000 sq. ft. Constructed by direct labour (by Messrs. Vandenbergh and Black Ltd., 1948).

Go-Downs and Transit Sheds—continued

Compression in the Concrete.

So far as the statics are concerned, the less the rise for any given span the greater the compression in the concrete, i.e. the greater the natural prestress; wind resistance and the effect of earthquake are reduced and overall stability is increased.

The term pre-stress is used advisedly. It is highly fashionable in these days and in the case under discussion it is not an artificial pre-stress induced by mechanical means. Pre-stress in the concrete of these shells derives from gravity, is equally beneficient as the artificial variety, and whatever may or may not happen in other cases—gravity will not let go.

Table I shows the compression at springing for all ratios likely to be usefully employed and even for very large spans these stresses are in no case likely to cause anxiety.

Table I.—Compressive Stresses at Springing of Concrete Arch.

Rise span ratio	Span : feet					
	60	100	150	200	300	700
	Compressive stress : lb. per square inch.					
$\frac{1}{2}$	51	84	126	168	253	591
$\frac{1}{3}$	47	79	118	157	236	551
$\frac{1}{4}$	50	82	123	165	247	577
1 5	54	89	134	179	268	626

Shell Thickness.

As mentioned above the shell thickness may be as little as 1-in. but as it is desirable to apply the concrete in at least two coats in order to reduce the effect of minor imperfections in workmanship (see below) the lightest shell recommended is $1\frac{1}{2}$-in. placed in two $\frac{3}{4}$-in. coats.

When steel is introduced the thickness in first-class work should be at least 3-in.:

internal cover	$\frac{3}{4}$-ins.
allow for reinforcement	$1\frac{1}{4}$-ins. to $1\frac{1}{2}$-ins.
external cover	1-in.
Total	3-ins. to $3\frac{1}{2}$-ins.

The nett room taken up by steel in the slab rarely exceeds $\frac{3}{4}$-ins. but a margin must be allowed and in this class of work one and a quarter inches is considered reasonable for the steel-containing zone. A properly constructed concrete arch must be regarded as being in the highest degree durable. This longevity must not be jeopardised by cutting down cover in order to effect a paltry saving in concrete—the one material that still remains relatively cheap.

Reinforcements.

The use of reinforcements, if any, is a matter largely for individual judgment. The following considerations may be of interest.

As far as fulfilling the conditions laid down in official building regulations goes it is possible to dispense with reinforcements entirely and to follow the practice of the unnamed but surely not unrespected old-time builder of that unique monument to engineering skill and foresight—the Great Arch of Ctesiphon (see Fig. 7).

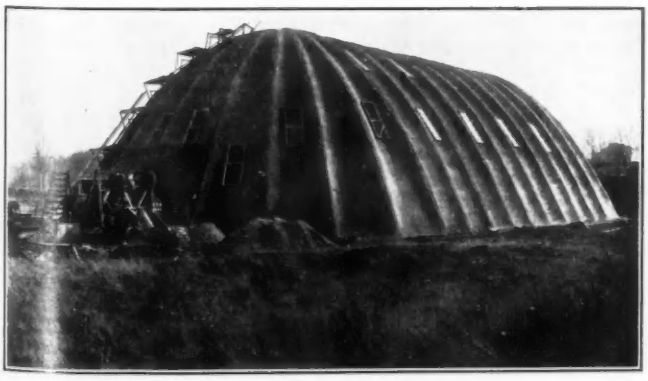


Fig. 5. Laboratory, 60-ft. span (by H.M. Ministry of Works, Barnet).

Fig. 6. Workshops at Royston, Herts. Twin 50-ft. spans. Built by direct labour (by Messrs. Goodes Engineering Co. Ltd., Royston).

In the modern version here discussed the only changes in practice from that of the Sassanian architect are the substitution of modern concrete for mud bricks and the corrugated for the ancient solid section.

On the other hand, owing to the comparatively great lever arm provided by the corrugation even a little transverse steel has great effect. It is suggested that something of the order of $\frac{3}{8}$-in. rods at 1-ft. centres transversely in spans over 40-ft. is advisable since they form a safeguard against any possible movement of foundations, earthquake, freak wind, accidental impact, the unpredictable hazards of war and the day when someone may require bulk storage which involves considerable outward pressure. Such a policy of assurance would seem to justify so reasonable a premium.

When it comes to horizontal reinforcements the case is quite different. These are required to control the effects of temperature variation and initial shrinkage in the concrete as it matures: such movements cannot be prevented and, instead of allowing them to build up, reinforcements are used to ensure that the whole shall be concentrated and taken up by the joints.

No accurate method of computing the precise amount of steel required for this purpose is known to the writer and as there are many variables that confuse the problem it would seem unlikely that any will be developed. Experience so far indicates that $\frac{1}{4}$-in. rods at 12-in. centres are quite effective for a 2-in. shell with transverse joints spaced 24-ft. c. to c. and, by way of a further example, in the 150-ft. span shown in Fig. 3, 5lb. expamet has been specified with contraction joints at 34-ft. 6-in. c. to c. B.R.C. brickforce also makes a handy reinforcement and may be used at suitable spacing both transversely and longitudinally.

Foundations.

Foundations present no special problem in design. The thrusts, vertical and horizontal may be easily calculated from the values given in Table I, a percentage being added for wind, etc., to suit local conditions.

It must not be forgotten that settlement must be guarded against with greater care than in conventional steel framed buildings so that rafting, or piling with or without cross ties, may have to be resorted to in bad sites.

Insulation.

The insulating value of the concrete in the shell is calculated in the ordinary manner.

In considering heat penetration it should be remembered that the favourable conditions for natural ventilation that obtain ensure the complete elimination of dead air. When heat loss, on the other hand, is being considered the fact that the shell is air-tight is important. When extra insulation is required double shells with cavity may be used with economy.

Go-Downs and Transit Sheds—continued

Ventilation.

It is scarcely necessary to go into this matter in detail in the present article. In view of the excellent conditions for the natural circulation of the enclosed air, due to the arched form, it has been keenly disputed whether it is not more advisable to depend on natural ventilation in hot weather than to use fans. There would appear to be a good case for relying on the natural processes. In practice a certain amount of the sun's heat penetrates the sheil and warms up the film of air in contact by conduction : convection begins and this film immediately commences to creep upwards along the soffit and, if proper provision has been made, discharges through the ventilators in the crown. To interfere with this natural process by stirring up the air has been held to be a mistake. In one notable case, a sizal factory in Southern Rhodesia (Fig. 4) the ruling internal temperatures in the godown in which the raw material is stored met with highly favourable comment and, what is more important, a reduced premium against fire risk.

Mention of airtightness raises another point. With many products in bulk storage it is an advantage to have buildings that can be completely sealed in order to exclude termites and so that the processes of de-infestation may be carried out. In other cases a controlled humidity is desirable. The arches under discussion being monolithic are favourably placed in these respects.

Relating to Construction

Much thought has been given to keeping the actual processes of construction as simple as possible.

Falsework and Concreting.

Broadly speaking, two systems of falsework are available.

(I) Prefabricated ribs, constructed of tubes or light rolled sections. When these are erected a sheet of open weave hessian or similar material is stretched over the supports (see Fig. 8). A ¾-in. layer of concrete is applied to the hessian, which sags and so forms a corrugated shuttering and the internal cover for any reinforcements used. Next, the steel is placed and another coat which covers the steel goes on. Finally a third coat, to provide external cover is laid.

The usual precautions as regards curing, grouting between coats, etc., are observed. It is of prime importance to keep the shell thickness uniform. The mix recommended is three parts sand, concreting quality, to one of ordinary cement.

(II) For large spans, tubular or other adjustable scaffolding is preferred. This can be made up in travelling gantries as desired. A semi-flexible metallic sheeting, such as expamet, previously curved, may be used in place of hessian. As mentioned above this has the advantage of providing the horizontal reinforcement as well as the supporting means for the concrete.

As regards labour, the fact that no vertical surfaces have to be rendered avoids the necessity for skilled plasterers. Nearly all native labour possesses considerable skill in plastering and some of the very best Ctesiphon buildings is the result of their work.

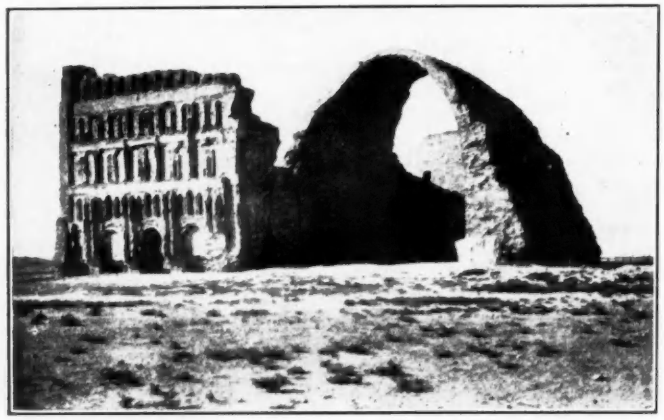


Fig. 7. The Great Arch of Ctesiphon. Believed to have been built by the Persian King Chosroes I, 531-79 A.D.

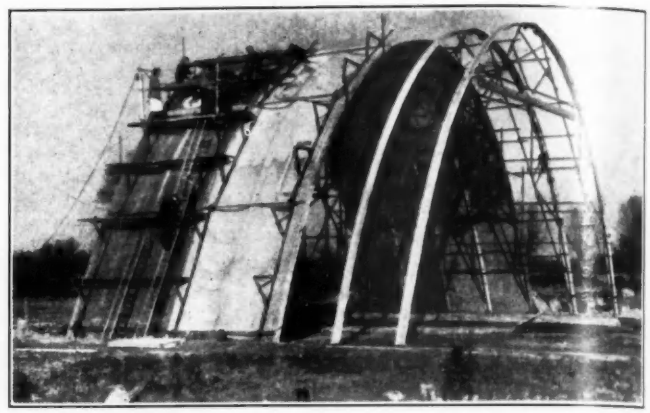


Fig. 8. Construction Photo. 60-ft. span. Showing Ribs, Hessian and Concreting.

It is appreciated that rendering applied in very hot weather is liable to be effected by flash setting which causes irregular crazing. In such cases a final bitumenous treatment may be necessary in order to ensure complete impermeability. Under normal conditions such treatment has rarely been found necessary.

Cost.

Cost is referred to in general terms several times in this article but it is desirable to deal with this matter in more detail. The system covers a wide range of structures and costs of labour, materials and transport vary so much in different parts that there is no short answer to this question. Costs must be estimated locally, as in all engineering works.

The following may be a guide:—

A 2-in. shell, as commonly used for small spans, calls for 30 cu. ft. of sand, 1,000 lbs. of cement and 17 sq. yds. of hessian per 100-ft. sq. of floor. To this may be added, say, 30 lbs. of steel when reinforcements are considered necessary.

For larger spans, as for example the shedding shown in Fig. 3 these quantities become, sand 42-ft. cu., cement 1,350 lbs., and steel 180 lbs. The above figures are for shell only. As for labour costs, again per 100 sq. ft. covered area; buildings up to 40-ft. span average out about 40 m/hours with 50 m/hours for 60-ft. span. A 100-ft. twin span came out at under 70 m/hours having a 2½-in. fully reinforced shell and valley. The 150-ft. example (Fig. 3) is estimated to take about double this figure. These figures include erection and striking of falsework and refer to work in the British Isles.

Conclusion

In conclusion it may be said that the original aims of the development which have led to modern Ctesiphon Construction here described were to find methods by which arch construction could be rationalised, which would eliminate heavy falsework, reduce the need for steel to insignificance, and which could be carried out as far as possible without the help of highly skilled labour.

In the result it is claimed that those aims have been met to a considerable extent, for quite apart from satisfactory initial costs, strength, durability, stability, fire and vermin resistance, and freedom from obstruction have been secured to a degree hitherto unavailable in conventional work.

The writer would like to conclude with the suggestion that when dealing with go-downs and transit sheds the designer should study schemes based on large spans in preference to those which involve a number of small buildings. One 150-ft. span Ctesiphon will, in most cases, cost little if any more than two 80 footers while in service the former will, in the majority of cases, prove to be the far better investment.

Further information on this subject see The Proceedings of The Institution of Civil Engineers, Part III, August, 1953. "Corrugated Concrete Shell Roofs" by J. H. de W. Waller, D.S.O., O.B.E., M.E., M.Sc., M.I.C.E. and A. C. Aston, B.Sc. (Eng.).

Dock Labour Troubles on the Waterfront

New York — London

Fourth Report of the New York State Crime Commission (Port of New York Waterfront), May, 1953.
Dock Labour Disputes in Great Britain—McKelvey, Cornell University Bulletin, March, 1953.

ON September 30th, 1953, the present agreement between the International Longshoremen's Association and the New York Shipping Association came to an end. The two Associations failed to reach agreement, though there was only 1.5 cents per hour difference between the 10 cents per hour increase claimed by the Union and the 8.5 cents. offered by the Shipping Association. A strike followed involving dockers along the Eastern seaboard from Maine to Virginia. Dockers in Halifax, Nova Scotia, were asked to support the American dockers by refusing to handle diverted ships.

President Eisenhower declared that the strike would " imperil national health and safety," and set up an immediate three-man inquiry as a preliminary to invoking the Taft-Hartley Act and securing a court order instructing strikers to return to work for a period of 10 days while negotiations proceed. For the moment the strike has been called off. It seems unlikely that agreement will be reached within this time. The Act empowers the Court to extend this period for a further 70 days.

The situation is serious; it cannot easily be resolved because much deeper issues are involved than the settlement of a wages rate. Some of these matters are not only revealed in the Commission's Report under review, but the Report itself precipitated affairs by indicting the dockers' union, the International Longshoremen's Association, of corrupt practices and of being largely controlled in the port of New York by gangsters or officials with criminal records.

The I.L.A., originally introduced to the port by the American Federation of Labour, has now been expelled from that body because it has failed to purge the organisation. The A. F. of L. has proceeded to set up a new rival union and has issued pamphlets and loudspeaker exhortations to the men that the " Ryan-Anatasia " negotiations were a " sell-out "[1]. It is reported, however, that the new union will not blackleg the I.L.A.

The Reports under review, one dealing with the conditions on the waterfront in New York, the other being an American view of English dock strikes are clearly related to the New York problem, and are of immediate importance for an understanding of this situation.

I

The Report of the Crime Commission is unequivocal in its statements, forthright in its denunciations, and almost frightening in the state of affairs it discloses. There are no reservations in its judgments. Even the setting of the print, with its damning statements in heavy type, with short staccato sentences in smaller type, as illustration drawn from the voluminous evidence, almost highlights in cartoon fashion the tragic drama behind the " shape up " on the water front.

Governor Dewey, who instigated the Commission in 1951, is a name feared in the underworld of New York because of his fearless pursuit of gangsterdom in the thirties. He has since proved a successful Governor of one of the key States in America. He has the prestige of a respected if unsuccessful presidential candidate. When, therefore, following certain preliminary studies, he set up a State Commission, adequately staffed with legal, accounting, investigating and police personnel, to conduct a sweeping investigation of waterfront conditions in the Port of New York, it must have been self evident that this was to be no whitewashing inquiry; and having regard to their police records, many of the Union officials involved must surely have felt some anxiety as to their future.

It is not only the management of the Union that is at issue, but the organisation and standards of business morality of employers and Unions of the Port of New York. Under the scathing indictment of the findings of the Commission, the employers can surely no longer countenance practices and customs to which they must have been willing or unwilling partners and which enabled the power of the Union to remain in the hands of men who are proven in some cases to have had criminal records, to have exercised graft and corruption on a large scale and, indeed, to have run the organisation in New York with many of the characteristics of gangsterdom.

The headings to the Sections of the Report indicate its scope:—

Section 1. Unhealthy conditions exist in the steamship and stevedoring industry.

Section 2. The I.L.A. and its component locals have flagrantly disregarded the welfare of their members and the public.

Section 3. Corrupt labour leaders use their offices for the promotion of private business interests, often illegal.

Section 4. The shape-up and the forcing of undesirable hiring foremen on the employers are basic evils.

Section 5. The public loading racket is a serious drain on the port.

Section 6. The present watchman system on the piers is ineffective and operates to the detriment of the port.

The Commission found that there was collusion between Steamship and Stevedoring Companies on the one hand and the Unions on the other, which by gifts and bribes to Union leaders " have served to maintain the power of the Trade Union leaders and to undermine honest administration of collective bargaining agreements." High officers of the Stevedoring Companies gave evidence of heavy payments made to Union officers, as one of them said "to prevent ' quickie ' strikes "; they tolerated " phantoms " on the pay-roll.

Nor were all the payments to the Union officials. Some Stevedores, who are named, paid large sums—three cases are quoted—to Steamship Companies to secure or maintain stevedoring contracts; they altered books and records to conceal these payments.

An example of the Employers yielding to Union pressure is that of the appointment of hiring foremen—the real bosses of the piers. Section 7 of the New York Shipping Association—I.L.A. Contract provides that the employer has the sole discretion to designate the hiring foreman. One witness, a superintendent of a stevedoring firm, said in evidence that although " that's in their contract, you can just as well take it out of their contract " because the employers have to take the Union nominee or face a strike.

For example, the foreman appointed in charge of Piers 90 and 92 —*Queen Mary* and *Queen Elizabeth* dock at this berth—following the murder of the hiring foreman in 1948, was known to have been " convicted of unlawful entry, arrested for attempted burglary, robbery and assault, to have been convicted of robbery and sentenced to from seven and one half to fifteen years in the penitentiary; and was still on parole when he was made hiring foreman." The employers appointed this man nominated by the Union as a condition for settlement of a strike.

This is only one of several instances quoted by the Commission of men with known criminal records being appointed by employers as hiring foremen. The Commission summarises this aspect of the

(1) Note—*Ryan:* President of the I.L.A. has recently been indicted for misuse of union funds (Report p.20 et passim).
Anatasia, Albert: " Six Brooklyn locals known as ' Carmarda locals ' were for at least ten years under the control of a group of notorious criminals headed by Albert Anatasia " .... (Report p.22).

Dock Labour Troubles on the Waterfront—continued

matter by stating that " while perhaps some of the Steamship and Stevedoring Companies are doing the best they can, many have yielded to the pressure and temptations of existing conditions."

The I.L.A. " flagrantly disregarded the welfare of their members." The ordinary longshoreman scarcely appears in the evidence before the Commission, though it is clear from the Report that he is throughout the victim of it all. " Many longshoremen, recalling the long series of unsolved murders on the docks, were deterred by fear from testifying."

One of the rank and file members gave evidence that he ventured to ask the business agent of the branch why he was " being charged $3 a month and weren't getting benefits from it. . . ." " The first thing you know, was I got kicked by someone. I don't know who it was, but I know I was arguing with him."

Q.—You got kicked in the groin? A.—Yes, Sir.
Q.—And badly hurt? A.—Yes, Sir.
Q.—You went to hospital? A.—Yes, Sir.

This is the voice of one of the 40,000 individuals who work from time to time as longshoremen, many of whom are casuals, with thousands more waiting for a chance occasionally to get work on the waterfront.

The branches — or " locals " — of the Union do not function democratically, or indeed sometimes at all; which is not surprising in view of the number of convicted criminals who are in control of the branches and the waterfront areas. At least 30 per cent. of the officials have police records. These officials in turn place their confederates in key positions on the docks and carry on such activities—in addition to " industrial activities"—as pilferage, loan-sharking, gambling and extortion. " We specify . . . " and so the Report's statements are documented, giving details ranging from corruption to thuggery, with names from the President Ryan of the Union—who has the power to employ and discharge these " organisers "—to notorious criminals who control branches, and have done so for more than a decade. One caption of the Report reads, " Ryan and many I.L.A. organisers are demonstrably unfit for their posts " (p. 20).

The men have gained little from all this. The earnings of more than half of the 44,000 men during 1951-52 were less than $1,400; one-third—said another witness—earned more than $3,000.

The Commission describes the method of hiring through the open call or " shape up " and rightly emphasises that the preponderance of surplus labour and low earnings makes possible much of the bribery and corruption necessary to secure work. " The ability of a man to get a job . . . depends almost entirely on his ability to persuade the hiring boss to give him that job, which puts him at the mercy of the hiring boss. . . ."

But the Commission is realistic. It recognises that the elmination of the shape-up alone will not resolve these problems; the hiring boss must go and all the other abuses. A comprehensive programme is necessary.

It recommends such a programme requiring:

(i) the City of New York to attend to the physical improvement of the piers and their approaches which are not adequately maintained and are congested;

(ii) Steamship and Stevedoring Companies to insist that their officials act in accordance with fundamental standards of business morality;

(iii) the American Federation of Labour to use its influence to stamp out the abuses in its affiliated Union—the I.L.A.; and,

(iv) there must be legislative action, through a Division of Port Administration set up as one of the departments of the State of New York. This Division should replace the shape-up by Employment Information Centres where all dock labour should be registered and engaged: it should licence all Stevedoring Companies which *inter alia*, " must maintain a complete set of books and records, and all pier superintendents, foremen, firms concerned with trucking, and port watchmen."

It is also recommended that a statute providing that labour organisation should conform to certain minimum standards may be necessary, though it is hoped that the Union will take the required action without legislation.

Having regard to the way in which the Union has previously successfully resisted pressure to re-organise from the Mayor of New York and, later circumvented, the operation of the Taft-Hartley Act and ended by leaving the same people in power, it is not expected that the Union will re-organise itself. " The exercise of the full police power of the State. . . is a necessary step." The Commission suggests that in addition to voluntary effort to right matters, the full authority of the Legislature will be required " to eliminate evils too long endured." It would appear, therefore, that the whole Augean stables have to be cleansed.

We in the United Kingdom can only hope that this stark revelation of the facts will give strength and authority to all those in America who wish to see this barbarianism stamped out.

It is not going to be easy. Those in authority are well entrenched; their methods are cunning and involve a great many people of high and low degree. Their power rests in great measure upon the fear of poverty and their capacity to give an occasional four hours work to the casual docker; it also rests upon the docker's fear, engendered by thuggery that stops at nothing. It is only necessary to have been on the fringe of gangsterdom to realize how powerful is this measure of fear that will silence even the most indignant and upright citizen.

And if the thuggery is removed by the force of Law—which is surely the only way—there will remain a vacuum in the Union which will be without any tradition of self government and without leadership.

If in all this, the United Kingdom can help by offering the advantage of its experience in the decasualisation of dock labour, that it should do freely and fully.

II

Such a state of affairs is almost incredible to an Englishman. It reveals something of the gulf between English industrial society and that of America, that is seldom appreciated against the background of the technological efficiency of the major industries in the States; it is a matter for conjecture whether or not the various productivity teams visiting America were given the time or the opportunity to study this aspect of the American Scene. The similarity of language between American and English too often conceals rather than reveals the dissimilarity of social standards. Yet without some understanding of these differences, it is not possible to appreciate the situation on the New York waterfront.

Until the depression of the thirties, the myth of the Fords and the Rockefellers dominated the ideals of the industrial worker in America. They had created an industrial kingdom through their own ruthless energy and industrial genius; that in the process, many had suffered misery and degradation was known and accepted; the end justified the means—though this was qualified by a later tradition that the industrial potentate should endow with his wealth a Foundation for the benefit of humanity. The essential belief, however, was the possibility of a mechanic becoming the master; of the individual securing power over the many.

This belief could be heard among workers in the doss houses of Chicago, in the shanty town, in the large scale factory; and also in the homes of the successful salesman, office manager, and on the campus of the universities throughout the States. Only among the Negroes and the Mexicans in Texas was there no belief in this myth.

The social distinctions in the United States were closely related similarly to economic struggle. The Negro was himself the lowest rung of the economic ladder and the workmen of other races were as adamant, though not as crude, as the Secret Societies to maintain their position relative to the " lower " groups. When opportunity occurred, even the Negro regarded the Mexican in the Southern States as of a lower economic status than himself. Among the " whites," there were similar distinctions and economic gradings. The Irish docker was a Yank to the Italian docker on the New York waterfront; the " Yank " considered the Italian a " dago." There was no unity among the workers, no sense of group solidarity, no commonality of interests—because, among other reasons, " I, the worker of to-day, may to-morrow escape and become the boss." This was not, of course, only an upward movement; many of the " bosses " of yesterday are the workers of to-day. " Go West " was for many pioneers economic exploitation, not a social ideal of working class equality; too often the Dust Bowl was its nemesis.

Dock Labour Troubles on the Waterfront—continued

Joint action among the workers was therefore defensive within very clearly defined economic and social limits. It had no political connotation—as has characterised English Trade Unionism; nor did American politics provide scope for any such outlet.

This is one aspect of the industrial scene in the States which is part of the background of the present Commission's findings and which makes plausible and comprehensible a state of affairs which otherwise appear fantastic to the Englishman at home. It is not our function to pass judgment; it is our responsibility to try to understand.

III

The longshoremen of the New York waterfront are New Yorkers, which means that they are of many races and of many nations. It is estimated that as late as 1880, 95 per cent. of the longshoremen of New York, both foreign and coastwise, were Irish and Irish Americans; the remaining 5 per cent. were German, Scotch, English and Scandinavian. By 1912, the Irish, though dominant, were followed as a close second by the Italians, who often gained a place on the docks as " green " labour—especially during a strike; they were accustomed to low wages and standards of living; they sought a job in the States and were willing to accept deductions from wages as commission to be divided between foreman, saloon keeper and native bosses. They looked after their own; if one became a foreman, he chose Italians from among the crowd which "shaped up" for work. Similar alignments are to be found among the negroes, the Jews, the Polak and, indeed, every minority on the docks.

This is another facet of the background of the organisation of the Longshoremen's Union.

It is not irrelevant to the present situation to recall that two early attempts to organise the longshoremen into Unions came from England. In the winter of 1890-91 an Englishman named Reed went to New York and succeeded in starting a Union of men working on the National Line Pier, but within a few months the Union died out.

A much more successful venture was started by Ben Tillet's young Union in 1896 as an effort towards bringing all dockers throughout the ports of the world into a common cause. It was Tom Mann who emphasised the importance of the large number of waterfront workers in America as a starting point for world organisation. The Tillet Union discussed the matter and from their funds subscribed some £300 which they sent with a Mr. Edward McHugh to New York. McHugh arrived at the right time; he proved to be a man the longshoremen soon could trust. By October, with the support of Henry George and Havelock Wilson, he had founded the American longshoremen's Union—or as it was more commonly known the " McHugh Organisation." It grew rapidly. Unfortunately, two years later, the secretary of the Union disappeared with the Union funds, the organisation disintegrated, and McHugh returned to England a disillusioned man. But something of the spirit and purpose of McHugh remained with the older dockers for many years afterwards.

IV

The question of the Leadership of the Union is important, but the Commission also indicts the system of hiring, and by implication raises the whole question of the use of dock labour: and that is why the American " Study of Dock Labour Disputes in Great Britain" is relevant: That the author was aware of the relationship of the study to the New York problem is clear by various references in the text and in the Preface in which she expresses the belief that " the material it contains will prove of interest to those people in this country who are currently concerned about the problem of reforms on the waterfront."

An English correspondent gave the author due warning as to the pitfalls " facing anyone, especially on the other side of the Atlantic, making a short survey of dock labour disputes; especially as one knows over here that the great bulk of the published material presents a picture which, if not actually wrong in fact, is so limited a part of the whole truth as to give a picture likely to be highly misleading." This is a sad reflection on English commentary and research ; but it is all too true. The patient, skilful and humane social methods of Beatrice Webb and Beveridge have all too frequently given place to romantic technicolor narratives of individual judgments based on gossip of the talkative elements in dockland. One Government Committee of Inquiry even sought out the unofficial leaders in the East End to collect so-called " evidence."

Mrs. McKelvey has relied almost throughout on documentary evidence, in spite of the warning of her English correspondent, but unfortunately without evaluating the merits of the various documents. The results are, at times, disconcerting. For example, it is said the Legget Report " will probably rank in years to come with the monumental Shaw Inquiry " — a view to which many people on this side of the Atlantic will find it difficult to subscribe. " The Economist " is frequently quoted almost ex cathedra, but no other weekly journal is ever mentioned.

While the author has avoided the pitfall of gossip—indeed, she was only in the country for one month during the summer of 1951 for the purpose of this Survey—it is unfortunate that while she had time to discuss the matter with the labour department of the Conservative Party, and others, " because of limitations of time and pressure of other studies, I was unable to interview any of the Union officials concerned." Yet she proceeds to repeat many strictures on the Union which, though familiar to English students and to the industry, do not become more true or less misleading because of repetition; the repetition of a half truth does not make a whole.

The study is well documented—though its footnotes are not always accurate.[1] The early part of the Survey dealing with prewar history is an excellent brief summary because the evidence has survived the test of time. It is in the war history and after, where contemporary material provides the evidence, that the evaluation of the documents used should have been checked by personal enquiry and investigation with those engaged in the industry. In fairness to the author, it must be agreed that the conclusions reached are similar to those reached by others " who have travelled a similar course."

V

The title of the study emphasises the disputes in dockland; Ministry of Labour statistics are quoted to show the number and extent of the Dock strikes between July, 1945, and September, 1951. The Economist's barbed comment (1950) is also quoted, i.e. that it would be a poor advertisement for the forthcoming Festival of Britain to invite overseas visitors to " come to London—to see the South Bank, Trooping the Colour and the dock strike."

Clearly, strikes of such magnitude constituted a serious threat to the nation's industry. They properly provoked public concern and public enquiry. It appeared that the benefits of decasualisation were accepted by the men but not its obligations; that the actions of the Dock Labour Board and its staff, if administratively correct were inflexible; that the Union was powerless and completely out of touch with its members; and that, in short, the Welfare State had failed in dockland.

There were those, of course, who were only too anxious to foster the chaotic strike situation as it arose for their own ends; some hoped to achieve a political advantage, either of extreme left or extreme right; some thought that the strikes proved that only a return to the old days of a full labour market with surplus labour always on call would introduce discipline in the industry and hoped that the strikes would end the Decasualisation Scheme. Such were a very small minority. They did not create the strikes but were ready to exploit the resulting situation. Sometimes, as in the case of the unofficial leaders, they showed resource and cunning in their exploitation. They had the advantage which was denied to Union officials and employers in that they had no continuing responsibility either for the past (they were seldom traditional dockers) or for the present for the hardship they caused, or for the future.

The sub-title of the Report is " A Study in the Persistence of Industrial Unrest." But there was not a persistent continuing ferment among the mass of the men.

An analysis of the strikes reviewed in this study—particularly in the case of the "Zinc Oxide"—indicates that the strikes were not

(1) E.g. p. 42, Union membership is not a condition of employment throughout London, as the note suggests, nor were the men who were expelled from the Union following the Canadian Seaman's Strike thereby removed from the docks.

Dock Labour Troubles on the Waterfront —continued

premeditated by the men involved. Quite frequently strikes may start—as in the " Zinc Oxide "—from what the Americans call a " quickie " ; that is they centre round an immediate and local issue such as an argument as to the rate of pay for a particular cargo. Often the matter is settled by spot negotiation. It is when the localised issue becomes merged with some almost atavistic mass cry and loyalty as, for example, that " one of us is hurt " that a mass stoppage usually occurs. In such circumstances, the majority do not reason before they come out; they come out first and reason afterwards. It then takes some time for them to sort the position out among themselves. During his period, the unofficial leader becomes vocal; he explains, not what is wrong—the original sore is usually completely ignored—but what he and his small group wish the men to accept as the grievance.

VII

In spite of its limitations, this Study may serve an important purpose in the troubled state of affairs on the New York waterfront. Because of this possibility, it appeared desirable to comment upon and amplify certain conclusions reached therein. The Review is well written and presents an admirable brief summary of the history of some fifty years striving in England towards decasualisation, which until 1940 got no further than voluntary schemes of registration. Some of the Recommendations of the New York Commission could well be examined in the light of the narrative given in the McKelvey Review. It may well be that the British experience in trying to decasualise a casual industry and, over the last 12 years, of controlling dock labour through various schemes may be of value in the next "eighty days" of the Taft-Hartley truce.

It is an explosive situation. The boundaries of dockland extend not landwards but seawards across the trade routes of the world; there are no frontiers here; news travels fast, unfettered and free in this world of the sea. Those employed in the Port Transport Industry in this country will watch with some anxiety the resolution of the difficulties in New York.

Fendering, Lead-In Jetties and Dolphins

Correspondence from the Chief Engineer of the Port of Rotterdam

To the Editor of *The Dock and Harbour Authority.*

Dear Sir,

I have perused with great interest Mr. Robertson's article on the above subject in the May issue of " The Dock and Harbour Authority," on which I take the liberty of sending you some comments.

I agree that hardwood is very well suited for energy absorption and therefore in some way is indispensable in maritime construction work—it is used a good deal in the port of Rotterdam. I feel obliged, however, to draw attention to the fact that the comparison with steel is not complete and therefore I feel that, in some respects, Mr. Robertson's conclusions do not entirely hold true.

Actually, consideration should be given not only to box piles and broad flange beams, but also to tubular pipes, which have—especially when high tensile steel is applied—outstanding qualities for energy absorption.

To illustrate this point the characteristic lines of energy absorption for some tubes used in the novel type of dolphin now under construction in our port have been drawn up into the chart given in Fig. 3 of Mr. Robertson's article (see Fig. 3a below). The tubes have an outward diameter of 28.5-in. and 20.5-in. respectively and a wall thickness of 15/16-in. and 9/16-in. respectively, whilst the steel quality varies from St 58 to St 70 for the bigger size, and from St 65 to St 75 for the smaller size tubes in accordance with the B.M. diagram, the stress at limit of proportionality being 28.5 tons per sq. in. and 29 tons per sq. in.

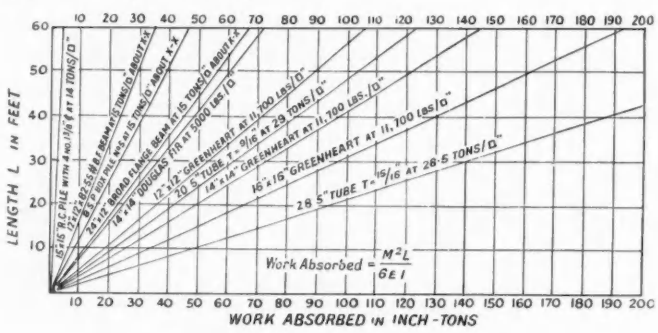


Fig.3a. Work absorbed by Members in Bending.

Also the deflection and static resistance of tubes compare not unfavourably with greenheart piles.

To show the potentialities of the application of tubular sections

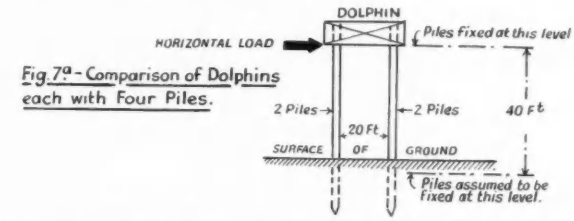


Fig.7a - Comparison of Dolphins each with Four Piles.

	B.S.P. BOX PILES WP5	14"x14" GREENHEART PILES	16"x16" GREENHEART PILES	20·5" TUBES T = 9/16"	20·5" TUBES= 11/16 21·5" TUBES= 5/16"	28·5 TUBES T= 15/16"
WORK ABSORBED	125 INCH TONS	390 INCH TONS	554 INCH TONS	331 INCH TONS	400 INCH TONS	745 INCH TONS
HORIZONTAL LOAD RESISTED	45 TONS	39·8 TONS	59·4 TONS	81·8 TONS	100 TONS	256·8 TONS
DEFLECTION UNDER LOAD	5·54 INCHES	19·6 INCHES	18·1 INCHES	7·8 INCHES	7·62 INCHES	5·2 INCHES
RESISTANCE MOMENT OF PILE	2700 INCH TONS	2390 INCH TONS	3565 INCH TONS	4900 INCH TONS	5980 INCH TONS	15400 INCH TONS
FORCE IN EACH PILE DUE TO OVERTURNING MOMENT	22·5 TONS	9·9 TONS	29·7 TONS	40·9 TONS	50 TONS	128·4 TONS
STRESS DUE TO BENDING	15 TONS/□"	11,700 LBS/□"	11,700 LBS/□"	29 TONS/□"	29 TONS/□"	28·5 TONS/□"

for dolphins of the type given in Fig. 7 of the above mentioned article, the data therefore is added in Fig. 7a herewith.

It should be emphasised, however, that not only must thought be given to either work absorption or horizontal load resistance but also to the most favourable combination of both, taking into account the work to be absorbed due to water displacement and berthing velocity of the vessels, on the one hand, and the force ensuing from wind pressure on the ship or pull from the mooring ropes, on the other. The same result can also be reached by increasing the wall thickness on the pipe diameter, the former accounting thus for at least 400 inch tons, the latter varying—depending upon local conditions—from 80 to 125 tons.

In the case of horizontal load resistance, the construction on four 14-in. greenheart piles—though having good energy absorption qualities—would fail unless the number of piles were doubled or tripled, this, however, would entail a much greater work absorption, i.e. resilience than is needed (and which in certain cases can be felt as a disadvantage). On the other hand, of the construction on four tubes of 20-ft. 5-in. it is to be said that, though it can stand up to the required minimum horizontal load, its energy absorption is not quite sufficient. By increasing the number of piles, however, by 25 per cent. or by 50 per cent., in both respects a satisfactory solution will be reached.

The foregoing calculations are based on a construction of piles with both ends fixed. However, another technical possibility to be envisaged is to have only the bottom ends fixed whilst the connection at the top is hinged or flexible. The data in the following table (Fig. 7b) show that for such a solution also, tubular steel is in no way less efficient than greenheart.

It will be evident that a similar construction from a static point of view, would be less attractive with greenheart piles. The application of tubular steel sections therefore makes, in either arrangement, a very favourable solution possible due to the fact that the diameter, the wall thickness and the steel quality can be varied to meet practically any demand. Whether the arrangement with

Fendering, Lead-in Jetties and Dolphins—continued

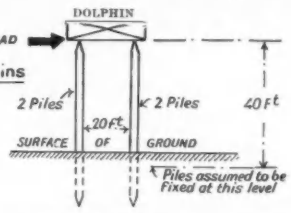


Fig. 7b—Comparison of Dolphins each with Four Piles.

	B.S.P. BOX PILES No's.	14"x14" GREENHEART PILES	16"x16" GREENHEART PILES	20·5" TUBES T = 9/16"	41" TUBES T = 5/16"	26·5" TUBES T = 10/16"
WORK ABSORBED	12·5 INCH TONS	390 INCH TONS	554 INCH TONS	331 INCH TONS	400 INCH TONS	745 INCH TONS
HORIZONTAL LOAD RESISTED	22·5 TONS	19·9 TONS	29·7 TONS	40·9 TONS	103·2 TONS	128·4 TONS
DEFLECTION UNDER LOAD	11·1 INCHES	39·3 INCHES	37·1 INCHES	16·1 INCHES	7·9 INCHES	11·4 INCHES
RESISTANCE MOMENT OF PILE	2700 INCH TONS	2390 INCH TONS	3565 INCH TONS	4900 INCH TONS	12400 INCH TONS	15400 INCH TONS
FORCE IN EACH PILE DUE TO OVERTURNING MOMENT	0 TONS	0 TONS	0 TONS	0 TONS	0 TONS	0 TONS
STRESS DUE TO BENDING	15 TONS/□"	11.700 LBS/□"	11.700 LBS/□"	29 TONS/□"	29 TONS/□"	28·5 TONS/□"

both ends fixed or with only the bottom end fixed shall be favoured depends largely upon the soil conditions.

In Fig. 7c the comparative data are given for various solutions able to absorb an energy amount of not less than 400 inch tons, as well to resist a horizontal load of not less than 100 tons.

To approach the problem from a financial point of view in the first place a comparison of costs can be made on the basis of expenditure either per inch ton of energy absorbed, or per ton horizontal force resisted. Such a comparison shows that steel construction with tubular sections on an energy absorption basis is considerably more expensive than hardwood. However, as such a basis can be erroneous as stated before, it is imperative to compare various constructions as a whole. Notably the divergence of

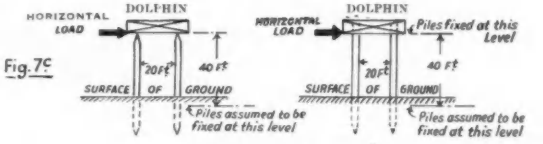


Fig. 7c

	4 41" TUBES T = 5/16"	10 14"x14" GREENHEART PILES	7 16"x16" GREENHEART PILES	5 20·5" TUBES T = 9/16"	4 20·5" TUBES = 11/16" 4 21·5" TUBES = 5/8"
WORK ABSORBED	400 INCH TONS	975 INCH TONS	970 INCH TONS	412 INCH TONS	400 INCH TONS
HORIZONTAL LOAD RESISTED	103·2 TONS	101 TONS	104 TONS	102 TONS	100 TONS
DEFLECTION UNDER LOAD	7·9 INCHES	18·6 INCHES	17·7 INCHES	7·68 INCHES	7·62 INCHES
RESISTANCE MOMENT OF PILE	12,400 INCH TONS	2390 INCH TONS	3565 INCH TONS	4900 INCH TONS	5980 INCH TONS
FORCE IN EACH PILE DUE TO OVERTURNING MOMENT	0 TONS	20·2 TONS	34·6 TONS	51 TONS	50 TONS
STRESS DUE TO BENDING	29 TONS/□"	11.700 LBS/□"	11700 LBS/□"	29 TONS/□"	29 TONS/□"

costs becomes much less as the following percentages based on the purchase cost of the piles only for the cases specified in Fig. 7c (roughly) show—180, 100, 100, 200, 170.

Moreover, due consideration should be given to the advantages and disadvantages inherent in the use of either of the materials from a structural point of view as far as specific cases and solutions are concerned, as well to the ancillary costs for driving, making of the necessary connections, bracings, etc

In connection with some dolphins for a new berth in the Port of Amsterdam, accommodating the biggest oil tankers and providing a depth of some 40-ft. thus necessitating a pile length of nearly 100-ft., a thorough investigation was made of all aspects of this problem including that of the time of delivery, the conduct in the long run and under eccentric loads, and the consequence of excessive impacts either from head-on or glancing blows.

It was finally decided upon a construction with steel tubes fixed only at the bottom, as in no other way could be found a more simple and in all respects satisfactory solution*.

Harbour Works Department,
Port of Amsterdam,
Holland.

Yours sincerely,
I. T. J. RISSELADA,
Chief Engineer.

*An article on these dolphins will be published in a later issue of this journal—*Editor.*

Faster Cargo Handling

Palletisation and Unit Loads

The United Kingdom National Committee of the International Cargo Handling Co-ordination Association held a one-day symposium on unit load and palletisation on board H.Q.S. "Wellington," Victoria Embankment on October 1, under the chairmanship of Mr. D. Rylandes Smith. The meeting was opened by Rear Admiral A. L. P. Mark-Wardlaw, president of the executive committee, who read a message of good wishes received from Mr. Lennox-Boyd, Minister of Transport. Delegates were welcomed from a number of maritime countries.

Four papers were read and were followed by a discussion and the showing of " Unit Loads," the first of, what is hoped will be, a series of I.C.H.C.A. films for distribution to anyone interested in the advancement of modern methods of cargo handling.

" Unit Loads and Palletisation."

In the absence of M. A. Vincenti, who represents stevedoring associations in French ports, his paper, entitled " Unit Loads and Palletisation," was read by Commandant P. Garoche. The author (M. Vincenti) discussed the development of palletisation in France and the problems it raised. It was obvious that modern methods of handling—and particularly the use of fork-lift trucks and pallets — could only develop fully if the organisations concerned could use mechanical equipment to its fullest capacity, and with the aid of teams made up in exact proportion to the work to be done. They must proceed with caution.

One obstacle met with when using fork-lift trucks at seaports was that, very often, the open quay and floor space of warehouses was in very bad condition. That had necessitated the use of fork-lift trucks with pneumatic tyres, which were more expensive to purchase and maintain. French dock and harbour authorities should be asked to do something to improve ground conditions. There were sufficient fork-lift trucks to handle palletised goods in most ports. But there might be some where equipment was insufficient, and it would be necessary to ensure that palletised cargo could always command adequate handling apparatus. If palletisation increased, it would become essential to increase the use of mechanical instead of manual methods of loading.

At the present time there were difficulties; the structural arrangement of holds and 'tween decks often prevented the manœuvring of mechanical equipment, while the hatch coamings in the 'tween decks presented the same obstacles. Further, the 'tween decks and the battens in the holds are often not strong enough to bear 2-ton fork-lift trucks, which were the type most often used at ports. Shipping companies should ensure that certain strengthening and modifications were made to holds and 'tween decks in order that fork-lifts up to 2-ton capacity could be used. Should pallets be provided by the transport concern or by the manufacturer? Was it possible to envisage organisations owning "pools" of pallets which could be hired ? Their free entry was most desirable and it was also necessary that Customs formalities did not necessitate the unpacking of palletised goods at the port.

In the discussion that followed, speakers raised the problems of stabilising palletised hold cargo. The use of dunnage between loads was suggested. The proportion of general cargo which could be palletised, in the opinion of various speakers, differed between 50 and 80 per cent. Comdr. Colvin said an American shipping company had used a warehouse away from congested piers to palletise goods arriving by rail and road.

" Road Transport Afloat."

The second paper entitled " Road Transport Afloat " was written and read by Mr. John A. Bustard, a director of the Atlantic Steam Navigation Company Ltd. He recalled the opening of his company's Tilbury-Hamburg service in 1946 for the ferrying of vehicles for the Army of Occupation in Germany; traffic which still continued. The " drive-in and drive-off " advantages of the vessels used by the company — L.S.T.'s with a large carrying capacity—were soon brought to the notice of the manufacturers and exporters of vehicles, and many such shipments have been

Faster Cargo Handling—continued

made to the Continent. The speaker also referred to the transport ferry service between Preston and Northern Ireland established in 1948, and said that present traffic indications were such that it should not be long before three ships would be needed on the run to provide six sailings a week. During the last 12 months 26,816 vehicles were shipped, compared with 4,991 in the first year.

He described the advantages of the ferry transport service. It was quite usual to discharge 60-70 vehicles and load a further 60-70 within six hours, and the vehicles discharged would be on the roads within a few hours of the ship's arrival. Because the cargo came forward as a unit load in one vehicle on a through door-to-door service, the goods did not need handling from the time they were placed on the vehicle. That advantage of non-handling, coupled with speed, gave the shipper the virtual elimination not only of pilferage and breakage but also of a considerable amount of costly packing.

" The Case for Palletisation."

The third paper " The Case for Palletisation " was presented by Mr. D. R. Woodley, director of studies, School of Materials Handling. He said that palletisation gave several advantages: it increased the amount of merchandise storable in a given area; it banished manual lifting, resulting in a higher standard of health and reduction in accidents; and saved handling costs, ranging from 25 to 80 per cent. The speaker said that the majority of cargo ships to-day were not designed for the mechanical handling of materials. This was a pity as the cost of loading and unloading ships was sometimes more than the cost of operating them on voyage. He said that in Canada a ship had been built that could be boarded by the fork-lift truck direct from shore without an intermediate handling operation. These vessels, operating between some of the general and Great Lakes ports, had special side hatchways which let down on shore so that a direct link between shore and vessel was established.

That was an important step in the right direction, but the best use of palletisation would only be achieved by establishing an uninterrupted system from factory to dock, from port to port, and from port to consumer.

In a review of technical developments, he referred to the use of radio-telephony in port operation. It was one thing to have fork-lift trucks, but another to get the full use out of them. By installing a telephone control set in the traffic manager's office and fitting a receiver-transmitter on each truck, contact could be made between the controller and the truck within a 20-mile radius. Orders could be transmitted about each job. Storage figures could be recorded without any time lag, thus providing an up-to-the minute record. Radio-telephony could also be invaluable as a means of communication between ships, cranes and trucks so that a co-ordinated sequence of operations was more easily achieved.

After Mr. Woodley had finished his paper, the chairman called upon Mr. C. M. Gray, an official of the Australian Government, to give an account of the use of palletisation in that country. He said there had been considerable advance towards standardisation and it was computed that there were two million or so pallets of 48-in. by 48-in. nominal size (46-in. by 46-in. actual). Moreover, progress had been made towards standardising package sizes to fit this pallet; 84 package sizes had been evolved to give an exact pack and the Australian Armed Forces could package all their smaller items in eight or nine sizes. A slide-rule had been devised for computing the most suitable package size.

" Ship Types and Through Transport."

In the fourth paper entitled " Ship Types and Through Transport," Mr. A. C. Hardy described some proposals for ships of unorthodox design, having as their main object delivery of goods from door to door, in order to cut down the handling and to lessen the chance of pilferage and of damage en route. Many types of cargo lend themselves to transport by lorry or goods wagon and the ship could in such cases be a smooth link in a system of through transit. A British shipbuilding firm had built for American ownership the first of the so-called " Seatrain " ships, vessels with machinery aft, into which were loaded standard railroad goods wagons. These ships have 'tween decks and lifts connecting one deck with the other. Each deck has rails and wagons can be moved fore and aft on railway tracks by capstans. Perishable products could be carried in the wagons with temporary refrigerating units connected to the ship's power supply. In addition, the Seatrains were equipped with side tanks for carrying fuel oil or cargoes to Havana and vegetable oils and liquid sugar on the return trip.

Some slides featuring modern air transport applications of palletisation were shown by Mr. A. G. Shove, of the Blackburn Aircraft Company. Mr. F. Strakosch, of Trieste, displayed a new type of refrigerated container developed in Italy. Made of light alloy, it has a capacity of 11 cu. metres, weighed only three tons empty, and is powered by two electric motors which connect with any power supply afloat or ashore

Book Reviews

" Handbuch fur Hafenbau und Umschlagstechnik " (Handbook of Port Engineering and Cargo Handling etc.), demy-quarto, 230 pages, price 15 German marks, published by Schiffahrts-Verlag " Hansa," C. Schroedter and Co., Zippelhaus, 5, Hamburg II.

This is a well printed omnibus volume replete with illustrations compiled from articles published in the old established weekly review " Hansa " : a publication devoted to all technical matters concerning ships, sea-going and transhipment traffic and ports. All the articles are written by well known experts, some, like Professor Agatz, enjoying a reputation for professional ability in this country and overseas. The contributors include Messrs. A. Bolle, Kurt Forster, G. Krauss, F. Muhlradt, K. E. Naumann, H. Neumann, W. Pohle, W. Schenk, F. Sulz, and O. Wundram, Doctor Engineers of established standing.

In all there are 40 contributors whose work has been grouped under six separate headings.

(1) Survey of the work of the Institution of Harbour Technology.
(2) Sea and Inland Waterways.
(3) Shipping and Harbours.
(4) Inland Waterways Shipping and Ports.
(5) New methods and Construction in Harbours and Ports.
(6) Cargo Handling etc.

There is almost a complete absence of mathematics in the volume, the emphasis is on practical matters, method, design and management.

(1) In this section there are 7 contributors including Prof. Dr. Ing. Agatz, whose customary concise and logical expression gives a clear picture of the activities and the practical nature of the work carried out by the " Hafenbautechnischen Gesellschaft" (roughly translated " Institution of Harbour Technology "). He records that this corporate body has already had harmonious collaboration with many foreign colleagues in the attempts to solve common problems.

This section points out the necessity for good professional practice in port arrangement and working facilities, which connotes a thorough consideration of the adaptability to possible future changes as indicated by modern trends.

(2) The eight contributors to this section deal with the technical location, economy and arrangement for the linking up of seaports with inland ports considering examples of Kiel, Rhein-Herne, and the Dortmund-Ems canals and the waterways of the Elbe, Weser and Ems.

(3) and (4) These two sections are descriptive of works carried out and details of practical re-construction of war damaged buildings etc.; not only in Germany but overseas. There are eighteen contributors, of which Senator Harmssen of Bremen is responsible for the introductory article on " Harbours as the power centre of political Economy." His views are forthright and worthy of careful consideration. He contends, and rightly so, that the modern sea-port is a complete organism which plays an immense part in the distribution process of political economy in an unending series of necessary functions of " ways of living."

Book Reviews—continued

Drs. Muhlradt and Henney subscribe articles on observations made on visits to West European Ports and English Ports respectively. Their criticisms are refreshing and instructive.

(5) The twelve contributions in this section are interesting and informative. They give in a kaleidoscopic way a clear picture of the untiring energy and ingenuity of German engineering practime; of the individual anxiety in all crafts associated with ports, particularly Hamburg and Bremen, to achieve the best possible for themselves and their communities. The application of prestressed concrete in sheds, bridges and quays construction; the use of light-weight concrete as an insulating and structural material for roofs and walls; the varied forms of shed design in various materials; the bold designs of re-inforced concrete landing stages and pontoons; the different forms of mooring and lead-in dolphins make valuable data for all port engineers.

(6) Cargo-handling in ports has always been a debatable subject, and the eighteen articles in this section may not be approved universally but they do show that the writers have a firm grasp of the problems involved. There is little doubt of the truth of a wise remark in this respect made by M. Pierre Callet the Director of the Port of Havre that " the social climate of the port is the main factor affecting the efficiency of working." Hamburg and Bremen are fortunate for in both places it is excellent. The contributors deal with present-day trends where ships as distributing agents are directly related to lorries, wagons, sheds, river and canal craft and coastal craft. For all who understand the German language this volume is an undoubted boon. R.R.M.

" Factory Health Safety and Welfare Encyclopaedia," by C. Conway Plumbe, B.Sc., formerly H.M. Superintending Inspector of Factories. Published by The National Trade Press, Ltd. Price 30s. net.

This book is an alphabetical work of reference to every substance, item of machinery or industrial risk likely to be encountered where factory work or conditions prevail. As such it may be of value to port operators. Under letter A, the author lists ablution, abrasive wheels, absenteeism, accidents causation, and proceeds alphabetically discussing each item from the point of view of health, safety and welfare, with special reference to the factory regulations appertaining. While it does not purport to give an official interpretation of the legal requirements of the Factories Act it serves as a useful guide to a great many miscellaneous problems encountered from day to day.

" Shipping Law." By Lord Chorley, M.A., and O. C. Giles, LL.M. Third Edition: Sir Isaac Pitman & Sons, Ltd. Price 30s. net.

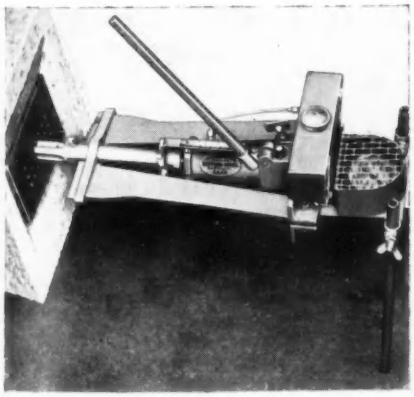
This is the third edition of an elementary text book written in non-legal language on the law relating to shipping. Its interest to dock and harbour authorities lies in its detailed and lucid explanation on the Contract of Affreightment and the legal problems arising from the loading and discharging of vessels. There is also a chapter on the legal relations between the shipowners and the port authorities and auxiliary services. New decisions and legislation have been noted and references to the Crown Proceedings Act 1947 included.

Manufacturers' Announcements

The Gifford-Udall Prestressing Jack

The new Gifford-Udall Prestressing Jack, and the CCL Anchorage System it incorporates, are the results of co-operation between the J. J. Udalls Building Co. Ltd., of Southampton, and Cable Covers Limited of Westminster, the manufacturers of " Talurit," the wire rope clamping system.

The Gifford-Udall-CCL Prestressing System is based on the simple method of prestressing, by tensioning the wires individually, thus enabling Jack and Pump to be combined into one light, compact tool easily operated by one man. The Jack will tension any size of wire up to 0.276-in., and for post-tensioned work, the wires can be arranged in groups of up to 12 wires in each duct. The extension is 4½-in. but alternative forms can be provided giving up to 14-in. extension.



Gifford-Udall Prestressing Jack.

The wires are anchored by standard CCL Anchor Grips as currently used on pre-tensioning beds, These combine a wedge action with an efficient mechanical grip which gives a secure fastening. For post-tensioning work these grips bear against mild steel plates at the end of the concrete member. Spring loaded anchor grips can be supplied when future extension of the wires is anticipated. In pre-tensioned work, the grips may be recovered and used many times over, thus effecting a considerable saving.

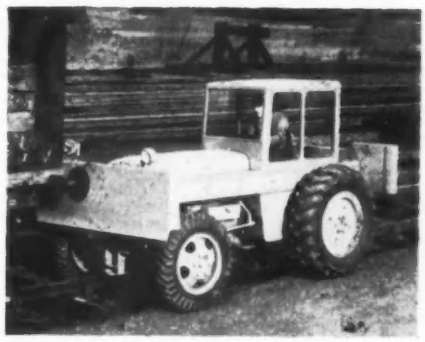
The Jack itself is designed to grip, extend and anchor a wire in such a manner as to eliminate any risk of slipping. Extension is measured against an adjustable rule and load on a direct reading gauge. The Jack and Pump, being combined, is easily transportable from one job to the next; its total weight is only 56 lbs.

It is claimed in that one man working alone, can tension and anchor at the rate 20 wires an hour after less than one hour's instruction. Any number of wires from one to twelve can be stressed in a duct, and any standard size of prestressing wire may be used, the tool being equally suited to post- or pre-tensioning.

It is thus possible to stress even small beams and frames economically, thus greatly increasing the field of application of prestressed concrete. The Jack and Pump combination can be purchased for £60, or hired if required.

The " Epping Auto-Shunter "

The " Epping Auto-Shunter " is rail-less and runs on pneumatic tyres. It is powered by a well-known diesel industrial tractor engine giving 42 B.H.P. at 1,700 r.p.m., and is designed to move loads of up to 150 tons on straight level rail For this purpose particular attention has been paid to correct weight distribution as well as to the design of the front axle assembly ; it was felt that if a machine of this type is to be 100 per cent. effective, it must also be capable of crossing over rails and points.



The " Epping Auto-Shunter."

Being independent of the rail yet at the same time able to cross over the track, this shunter can be immediately positioned for work whenever and wherever the need arises. In addition to normal shunting or towing operation of rail-borne traffic, it can be pressed into service as an ordinary industrial tractor when the need arises.

After taking initial and annual wear and tear allowances into account it is claimed that the capital cost of the machine in the U.K. represents no more than a weekly outgoing of between £2 or £3 depending upon the period of depreciation. On the operating cost side, approximately five shillings per hour should suffice to cover the cost of fuel, driver's wage, maintenance and ultimate engine and tyre replacement.

Manufacturers' Announcements—continued

New Company to Market Straddle Carriers.

Pest Control Ltd. of Cambridge have now formed a subsidiary company, British Straddle Carrier Company Ltd., which will be responsible for marketing " Timber Wolf " Straddle Carriers, and " Steelmaster " Straddle Carriers in the United Kingdom.

The latest models of these units, which the manufacturers claim to be the only straddle carriers produced in the Sterling area, are available with eight different dimensions of load aperture and a lifting and carrying capacity up to 18,000 lbs. All are diesel engine powered. Material Handling Equipment (Gt. Britain) Ltd., Export Managers for Pest Control Ltd., will continue to be responsible for the overseas sales.

New Dam Construction Contract.

Ransomes and Rapier Limited of Ipswich have been awarded a £570,000 contract for the construction of sluice gates and operating gear for the Government of Irak. This is for the Wadi Tharthar project, about one hundred miles north of Bagdad. It entails the construction of 17 barrage gates, each of 40-ft. span by 16-ft. deep, and 28 regulator gates, each 40-ft. span by 21-ft. deep, complete with operating gear. Nearly 4,000 tons of material will be used in their construction. All the work will be carried out at Waterside Works, Ipswich and will be shipped to Basra for Bagdad.

The Wadi Tharthar scheme will enable the flood waters of the River Tigris to be stored in a depression in the desert. During the low river season the stored water will be returned to the Tigris, increasing the supply of water for irrigation. This is the latest of a series of projects in dam construction that have been undertaken by this firm in Irak.

ERRATA

In the article " Go-Downs and Transit Sheds " on page 184 of this issue, the labour costs (second column) should read .40 m/hours, .50 m/hours and .70 m/hours for the respective spans mentioned.

SITUATIONS VACANT.

HEAD. WRIGHTSON & CO., LTD., require a fully experienced General Engineering Designer Draughtsman, capable of working with minimum supervision, over 30 years of age. A knowledge of dock gate work and moveable bridges would be an asset but is not essential. Apply, stating age, full details of experience, etc., and salary required, to Personnel Manager, Teesdale Iron Works, Thornaby-on-Tees.

THE BRITISH TRANSPORT COMMISSION (Docks and Inland Waterways), 22, Dorset Square, London, N.W.1, invite applications for the post of Engineering Assistant (Mechanical and Electrical), Garston Docks. Applicants should be capable of maintaining various types of dock mechanical and electrical equipment and of designing and carrying out new works of a major character. Candidates should be Corporate Members of the Institution of Electrical Engineers and/or the Institution of Mechanical Engineers. The starting salary will be at the rate of £875 p.a.

Applications, giving full details, qualifications and experience, should be sent to the Staff and Establishment Officer at the above address to arrive not later than 24th October, 1953.

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OFFICIAL APPOINTMENTS.

NIGERIA GOVERNMENT—PORTS.

The following officers are required to assist in the planning and organisation of the proposed NIGERIAN PORTS AUTHORITY. In the first instance they will be offered contracts under the Nigeria Government and if, on the creation of the proposed Ports Authority, they have proved themselves suitable they will be offered employment with the Authority. It is anticipated that they will be required to take over the Departments for which they are qualified.

TRAFFIC & COMMERCIAL ADVISER. (M3B/33972/DU.) Commencing consolidated salary £2,500 a year. Candidates must have strong organising ability and good experience of the administration, management and operation of wharves or docks (road and rail served) and warehouses, the compilation and levying of rates and charges, and first-hand experience of labour. Knowledge of mechanical cargo handling and shipworking an advantage.

ENGINEERING ADVISER. (M2B/30191/DU.) Commencing consolidated salary £2,500 a year. Candidates must be A.M.I.C.E. and have extensive practical experience in maintenance design and construction of wharf and harbour works, in river and estuary maintenance, dredging and reclamation, and in conservancy of waterways including hydrography. Some mechanical experience of marine dockyard operations desirable.

ACCOUNTING ADVISER. (M3B/33973/DU.) Commencing consolidated salary £2,000 a year. Candidates must be members of one of the recognised bodies of professional accountants and have extensive practical experience in the accountancy of a Ports Authority or similar type of undertaking. They must be sufficiently experienced to introduce a complete accountancy system.

SECRETARIAL ADVISER. (M3B/33974/DU.) Commencing consolidated salary £1,750 a year. Candidates must have had good experience in the Secretarial Department of a Ports Authority or similar undertaking with a knowledge of Board and Committee procedure, the preparation of agendas and minutes and first drafts of legislation, bye-laws, standing orders, etc. Must be able to organise an office.

Normal tours 18/24 months. It is the intention that the Authority shall prepare a Pension Scheme, and it may be possible to preserve existing pension rights. Outfit allowance £60. Free passages for each officer and wife and assistance towards cost of children's passages or their maintenance in this country. Liberal leave on full salary. Quarters will be provided.

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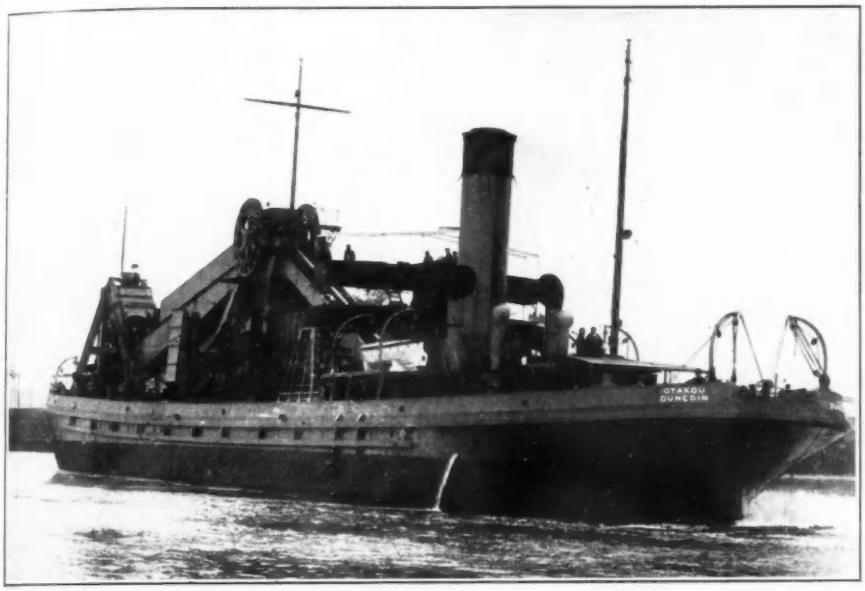

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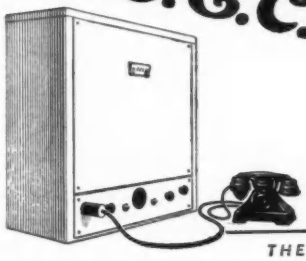

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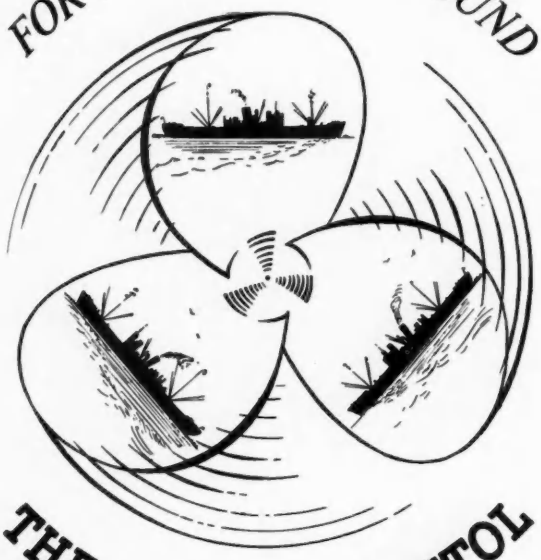

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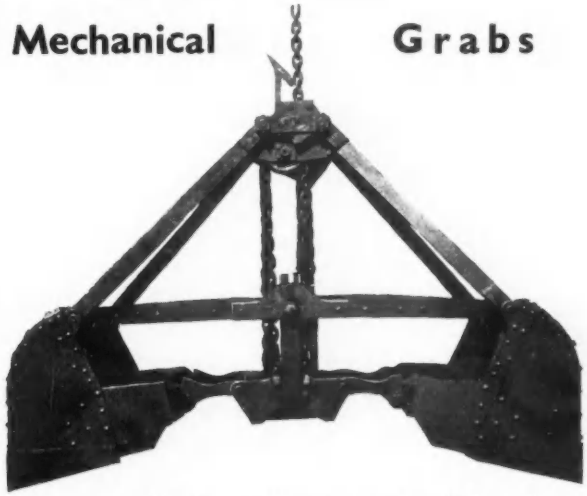

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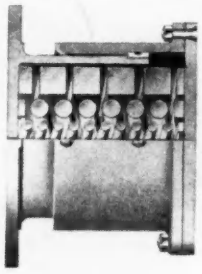

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	13"	30	2½	37
	17"	50	3	75
LONG RANGE TYPES	29"	10	7	28
	36"	30	12	135
	47"	20-25	16	135

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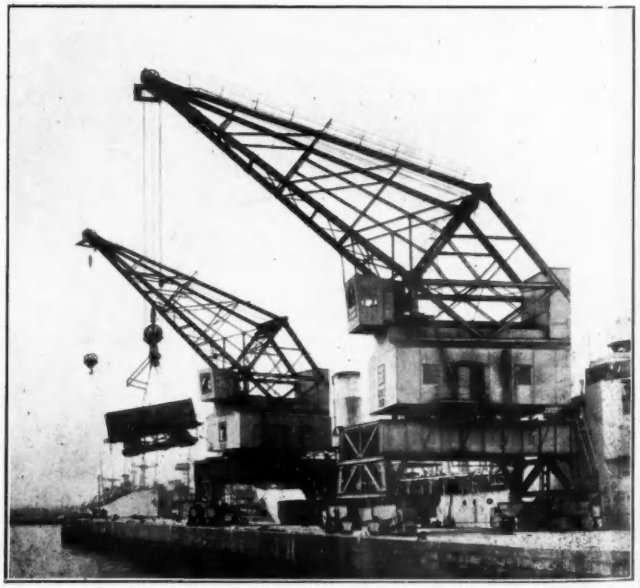

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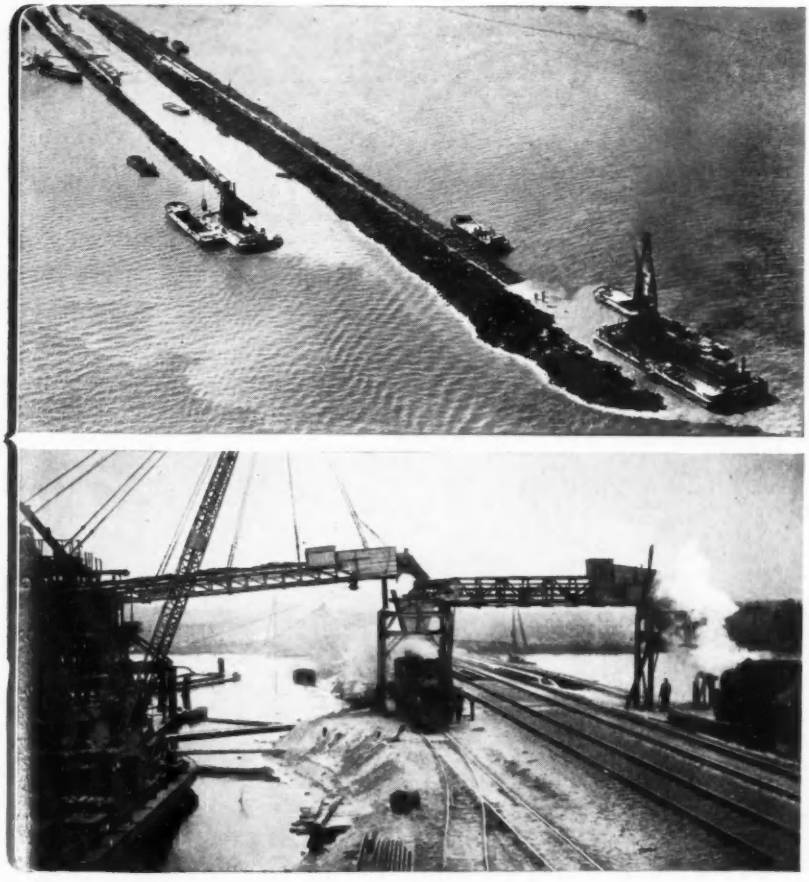

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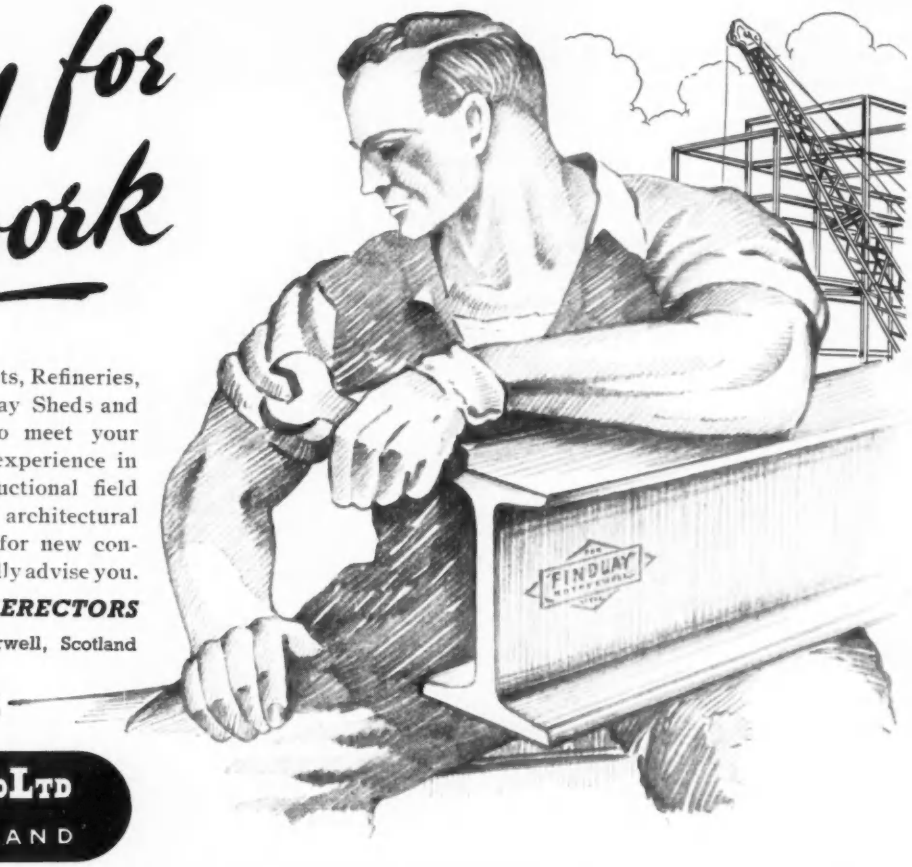

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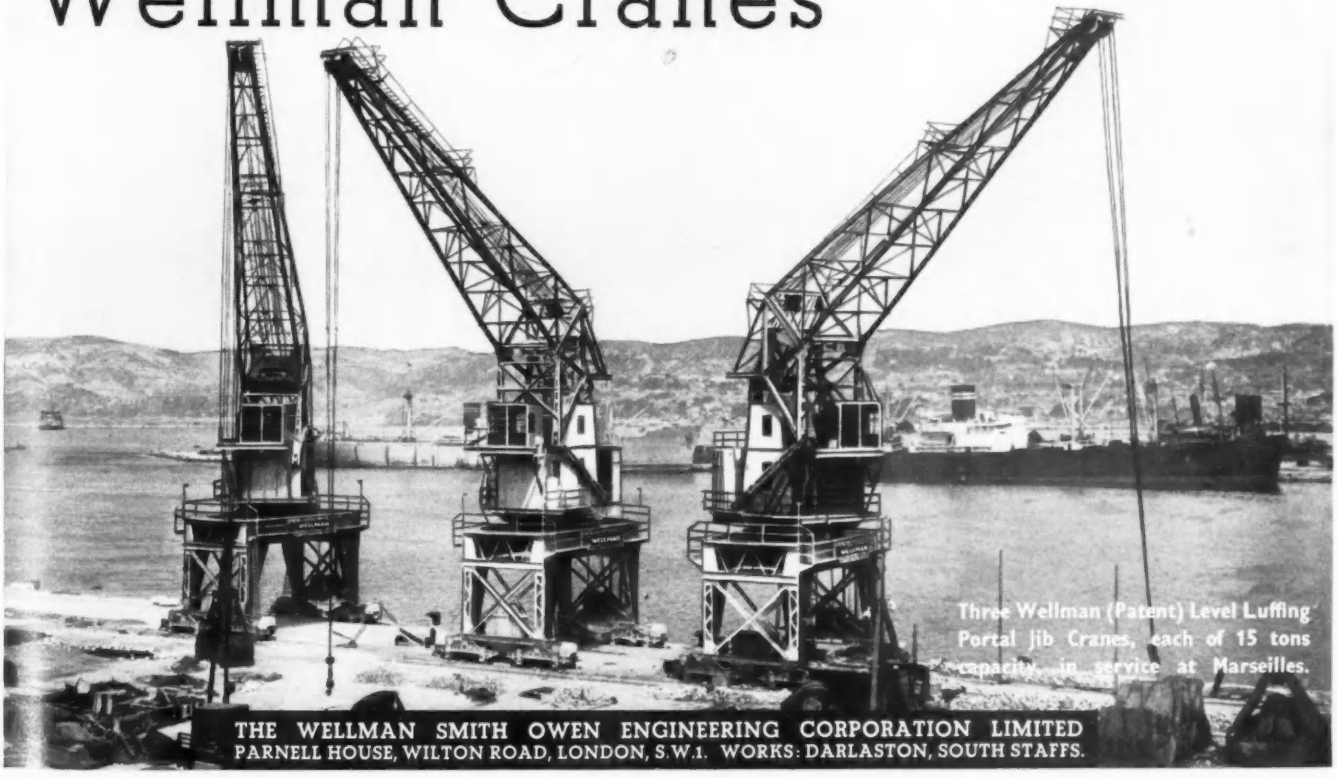

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